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NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T.
Accumulation of fallout ^{137}Cs in newborn infants, 23:50538
ISHIHARA, Toyokuki
Shielding effect of paraffin, water, soil, concrete, Fe, and Pb for high-energy neutrons, 23:51748

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

MELPHALAN
effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50820
MEMBRANE FILTERS
design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MENDELEVIUM
separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. (Los Alamos Scientific Lab., N. Mex.). Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

is indexed as:

LOS ALAMOS SCIENTIFIC LAB., N. MEX.
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 43988, 43989, and 44382.

43933 (CEA-N-1292) PROCEEDINGS OF THE MEETING ON AUTOMATIC CHEMICAL CONTROL, FONTENAY-AUX-ROSES, FRANCE, MARCH 10–11, 1969. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1970. 164p. (In French). (CONF-690345).

Separate abstracts were prepared for each of the 8 papers presented. (France)

For abstracts of individual papers see: 43937, 43938, 43960–43962, and 44061–44063.

Chemical and Spectral Procedures

Refer also to abstracts 44297 and 44356.

43934 (AECL-3556) CHEMISTRY AND MATERIALS DIVISION. Progress Report, January 1–March 31, 1970. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 98p. (PR-CMa-12). Dep. CFSTI (U. S. Sales Only). AECL $2.00.

Developments are reported for studies in: solid state physics, including ion penetration, electron microscopy, radiation damage and deformation; and nuclear chemistry; general chemistry, including analytical chemistry, fuel analysis, radioactivity measurements, heavy water analysis, electrochemistry, spark source mass spectrometry, and mass spectrometry; physical chemistry, including radiation chemistry and isotope chemistry; and materials science, including surface chemistry, ceramics, and metal physics. (P.C.H.)

43935 (ANL-7650, pp 35-40) ANALYTICAL AND REACTOR CHEMISTRY. (Argonne National Lab., Ill.).

Topics covered include: chemistry of irradiated fast-reactor fuels and materials; xenon tagging of fuel elements in EBR-II; and determination of burnup in fast-reactor fuels. (M.C.G.)

43936 (BARC-473) SPECTROGRAPHIC DETERMINATION OF SOME COMMONLY OCCURRING IMPURITIES IN PURIFIED LANTHANUM OXIDE. Grampurohit, S. V.; Swamy, K. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 11p. Dep. CFSTI (U. S. Sales Only).

A dc arc method is described for the estimation of fifteen commonly occurring impurities in lanthanum oxide. The sample is ground with graphite in the ratio 1:1 and 15 mg of this mixture is taken in the cavity of a $^3/_{16}$" graphite electrode which is used as the anode. A dc arc at 10 amps is employed to excite the spectra and a Hilger large quartz spectrograph is employed to photograph the spectrum in the region 2400 to 3300 Å. Ilford N-30 plates are used. The weak line of lanthanum, the matrix element, is used as an internal standard line. The working ranges of the various elements are: Ag, Be, Ge, Mn, Pb, Sn, and V—2 to 100 ppM; B, Cr, Cu, Mg, Ni, and Sb—5 to 100 ppM; and Co and Ti—10 to 100 ppM. (auth)

43937 (CEA-N-1292, pp 5-23) AUTOMATION IN CONTINUOUS ROUTINE ANALYSIS. PRESENT STATE OF PROGRESS IN THE SPECTROPHOTOMETRIC APPLICATIONS UNDER STUDY. Perez, J. J.; Arbogast, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

The automatic analyzers used at the present time must fulfill certain requirements: strength, multivalency, economy. Spectrocolorimetry was chosen as a measurement method because of its cost price. Some examples of applications are given: uranium(VI) determination to follow a run of ^{233}U extraction from irradiated Th; determination of small quantities of uranium(IV) (200 to 800 mg l^{-1}); analysis of iron and phosphates in samples of water from air coolers at Pierrelatte. (auth) (France)

43938 (CEA-N-1292, pp 25-8) THERMOMETRIC DETERMINATION OF THE FREE ACIDITY OF SOLUTIONS CONTAINING Pu, U, Fe, OR A MIXTURE OF THESE ELEMENTS. Guillot, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

A method was developed for the determination of the free acidity of nitric solutions containing Pu, U, Fe, or a mixture of these elements. Increasing amounts of base are added to samples in a calorimeter while the temperature is plotted as a function of the reagent volume. An abrupt change in the slope of the curve indicates the equivalent point. Some results are given on the determination of the free acidity of solutions containing U, U and Fe, U and Pu. (France)

43939 (CNEA-264) DETERMINATION OF INORGANIC RADIOIODINE IN COMPOUNDS LABELED WITH RADIOIODINE USING THIN-LAYER CHROMATOGRAPHY. Alvarez, J.; de Salas, G. N. B.; Raban, P.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 8p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

A large number of organic compounds labeled with ^{131}I were analyzed for ^{131}I in only fifteen minutes using 1N HCl as solvent. (auth)

43940 (NP-tr-1918) ABSOLUTE X-RAY FLUORESCENCE ANALYSIS. Ebel, Horst. Translated by M. Heinrich (BHP Central Research Labs., Shortland, Australia), from Z. Metallk.; 57: 454-7(1966). 7p. Dep. CFSTI (U. S. Sales Only).

The theory of an x-ray fluorescence analysis method is developed which enables the composition of the sample to be determined on the basis of a comparison of the intensities of the pure elements contained in the sample. The method may therefore be called an "absolute" one in the given sense. The experimental procedure for such an analysis is explained and illustrated by examples. (auth) (Australia)

43941 METHOD FOR DIRECT SPECTROGRAPHIC ANALYSIS OF MOLTEN METALS. Fassel, Velmer A.; Dickinson, George W. (to United States Atomic Energy Commission). U. S. Patent 3,521,959. 28 Jul 1970. Filed 29 Aug 1967.

For direct spectrographic analysis of molten metals the molten metal is nebulized by an ultrasonic transducer provided with a probe which is in contact with the surface of the molten metal. The droplets of molten metal are carried to a plasma torch by a stream of gas, which is at a temperature such that the droplets solidify quickly. Conventional spectrographic equipment is employed to obtain the spectrum of the metal. (Offic. Gaz.)

43942 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM(III) AND IRIDIUM(IV) WITH 8-HYDROXYQUINOLINE N-OXIDE. Gupta, R. D.; Manku, G. S.; Bhat, A. N.; Jain, B. D. (Univ., Delhi). Talanta; 17: 772-81(Aug 1970).

The spectrophotometric characteristics and the stability constants of the yellow to brown 1:1 and 1:2 complexes of platinum metals with oxine N-oxide (existing as chloro mixed-ligand complexes) were investigated. Oxine N-oxide can be used as a spectrophotometric reagent for ruthenium(III) and iridium(IV). (auth) (UK)

43943 URANYL COMPLEXES WITH PHENOLIC LIGANDS. XIII. REACTIONS OF UO_2^{2+} WITH 5-CHLOROSALICYLIC AND 4-AMINOSALICYLIC ACIDS. Havel, J.; Sommer, L. (Purkyne Univ., Brno). Collect. Czech. Chem. Commun.; 35: 45-61 (Jan 1970). (In German).

Formation of UO_2^{2+} complexes was studied spectrophotometrically in solutions and solids with 5-chlorosalicylic acid and 4-aminosalicylic acid. The results were compared with those obtained with other ortho-phenolcarboxylic acids. For spectrophotometric determination of uranium, either 5-chlorosalicylic acid or 4-aminosalicylic acid showed significant advantages in comparison to 5-sulfosalicylic acid. (tr-auth)

43944 MASS SPECTROMETRIC STUDIES OF RELATIVE SENSITIVITY COEFFICIENTS IN NICKEL- AND IRON-BASE ALLOYS. Bratton, W. D.; Wood, C. H. (General Motors Corp., Indianapolis). Appl. Spectrosc.; 24: 509-13(Sep-Oct 1970).

Mass spectrometric, relative sensitivity coefficients were determined for several elements in specific NBS nickel- and iron-base alloy standards. Concentrations of these elements ranged from several percent to only a few parts per million. The results indicate that the coefficients for many of the elements appear to remain nearly constant throughout a concentration range of an order of magnitude or more. However, some of the elements exhibit marked changes in the coefficient value as the concentration falls below a particular level. Matrix effects were also studied, and a definite trend toward a possible vapor pressure correlation with the sensitivity coefficients of the various elements was observed. (auth)

43945 CONCENTRATION-SPECTROGRAPHIC DETERMINATION OF PARTS PER BILLION OF SOME IMPURITIES IN METALLURGICAL PRODUCTS. Golden, G. S.; Atwell, M. G. (United Aircraft Corp., East Hartford, Conn.). Appl. Spectrosc.; 24: 514-18(Sep-Oct 1970).

A method is described for the determination of Ag, As, Bi, Cd, Cu, Ge, In, Pb, Sb, Sn, Te, and Tl at the sub-part per million level in a variety of materials. The elements are concentrated as sulfides using molybdenum as a carrier. After conversion to MoO_3, the residue is excited with a dc arc. Gold is used as both a chemical recovery and spectrographic internal standard. The method is applicable to any material whose matrix does not precipitate in acid sulfide solution. A single set of MoO_3-base synthetic standards is used. (auth)

43946 GRAVIMETRIC DETERMINATION OF SCANDIUM BY USING ANTIPYRINE AND AMIDOPYRINE. Eremin, Yu. G.; Katochkina, V. S. (Kalinin Polytechnical Inst., USSR). Zh. Anal. Khim.; 25: 1641-3(Aug 1970). (In Russian).

Optimum conditions for precipitating scandium quantitatively by antipyrine and amidopyrine have been established: a neutral medium, ≥10% KSCN, 3 to 5-fold and 2 to 4-fold excess of antipyrine and amidopyrine, respectively. A gravimetric method has been suggested for determining scandium with antipyrine (≥1.2 μg/ml) and amidopyrine (≥7.0 μg/ml) in the presence of 310-times more magnesium. (auth)

43947 SPECTROPHOTOMETRIC STUDY OF ARSENASO III AND ITS COMPLEXES WITH RARE EARTHS. Spitsyn, P. K.; Shvarev, V. S. (Ural State Univ., Sverdlovsk, USSR). Zh. Anal. Khim.; 25: 1503-9(Aug 1970). (In Russian).

The acid dissociation constants of arsenazo III have been studied for the second time by means of a spectrophotometric method. It is suggested that divergence in the constant values is due to impurities in the reagent. A study of the complexing of arsenazo III with all the rare earths has been carried out. Two ranges of the complex existence with a ratio Me:Ars III = 1:1 and of different stability have been established. It has been suggested that at pH 3.1 a composition of the complex corresponds to the formula MeArs and at pH 6.6 to 8.0 to Me_2Ars_2. A method for the determination of rare earths has been proposed. The method is based on the different behavior of the complexes in the systems rare earths–arsenazo III–$H_2O_2(H_2C_2O_4)$. (auth)

43948 PHOTOMETRIC DETERMINATION OF CERTAIN RARE EARTHS BY MEANS OF 1,10-PHENANTHROLINE AND TETRABROMOFLUORESCEIN. Poluektov, N. S.; Sandu, M. A. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 25: 1510-13(Aug 1970). (In Russian).

Rare earth ions interact with phenanthroline (Phen) and tetrabromofluorescein (Tf) to form complex compounds $MePhen_2Tf_3$. A method has been developed for the photometric determination of the total rare earths and for determining Eu in its mixture with La and Y, and Lu in its mixture with Y after masking with sodium fluoride. (auth)

43949 QUANTITATIVE PRECIPITATION OF CERIUM AS ANION–HALOGENATES OF CERIUM(III) HEXA-ε-CAPROLACTAM. Eremin, Yu. G.; Martyshova, T. I. (Kalinin Polytechnic Inst., USSR). Zh. Anal. Khim.; 25: 1514-16(Aug 1970). (In Russian).

Optimum conditions were established for precipitating cerium quantitatively as diiodoiodate (≅100 μg/ml of Ce) or dibromobromate (≅64 μg/ml of Ce) of Cerium (III) hexa-ε-caprolactam. Large amounts of Bi(III) and Cu(II) and microgram amounts of Fe(III), La(III), Pr(III), Sm(III), Gd(III), Cr(III) do not interfere. (auth)

43950 EXTRACTION–PHOTOMETRIC DETERMINATION OF THORIUM USING 5,7-DIBROMO-8-HYDROXYQUINOLINE AND RHODAMINE S. Mishchenko, V. T.; Zavarina, T. V. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 25: 1533-8(Aug 1970). (In Russian).

Thorium ions (Th^{4+}) form a mixed complex compound with 5,7-dibromo-8-hydroxyquinoline and rhodamine S. This compound is readily extracted by benzene within a wide pH range. The complex is formed at a ratio Th, 5,7-dibromo-8-hydroxyquinoline, and rhodamine S of rhodamine S of 1:5:1. Beer's law is valid for the concentrations of Th^{4+} down to 11 μg/ml, the sensitivity is 0.05 μg/ml (l = 2,5 mm). The method permits the determination of 1 to 45 μg of thorium in the presence of the rare earth oxides with satisfactory accuracy. For quantitative separation of the rare earths from thorium, the thorium complex is extracted in the presence of sodium sulfosalicylate or a sodium sulfosalicylate solution is used as a washing liquid. (auth)

43951 PHOTOMETRIC DETERMINATION OF CHROMIUM AND MOLYBDENUM IN HIGH-PURITY COMPOUNDS. Ichinose, Norio (Yamanashi Univ., Kofu, Japan). J. Jap. Inst. Metals; 34: 685-90(Jul 1970). (In Japanese).

Recommendable spectrophotometric methods have been developed for the determination of microamounts of chromium and molybdenum in high-purity thorium compounds. In the case of a chromium, a sample is dissolved in nitric acid containing a few drops of hydrofluoric acid by heating, and the solution is treated with potassium permanganate and urea–sodium nitrite as the oxidizing agent. The solution is mixed with diphenylcarbazide, and the absorbance of its color developed in the solution is measured at 540 mμ. For molybdenum, a sample is dissolved in hydrochloric acid containing a few drops of hydrofluoric acid by heating, and the solution is treated with potassium bromate–bromide as the oxidizing agent. Molybdenum(VI) in the hydrochloric acid solution (approximately 5.5 N) is extracted into n-butyl acetate. The n-butyl acetate extract is shaken with a potassium thiocyanate solution containing stannous chloride and hydrochloric acid, and the absorbance of its color developed in the organic phase is measured at 472 mμ. These methods were applied to the determination of chromium above 0.1 ppM (Cr/ThO_2) and of molybdenum above 1 ppM (Mo/ThO_2), respectively. (auth) (Japan)

43952 METHODS OF QUANTITATIVE SPECTRAL ANALYSIS OF SOME MICROELEMENTS IN MARINE SEDIMENTS. Meishtas, E. A. Okeanologiya; 10: 373-82(Mar-Apr 1970). (In Russian).

Improvements in the cathode layer and standards made with consideration for the macrostructure of marine sediment samples makes it possible to perform a spectral analysis of sediments without danger of large systematic errors. The allowable deviation of the macrocomposition of the sample from that of the standards used is different for specific elements and depends mainly on the inner standard applied. (auth)

43953 SPECTROPHOTOMETRIC DETERMINATION OF NITROGEN IN URANIUM USING THYMOL. Hashitani, Hiroshi; Yoshida, Hideyo (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 19: 1081-5(Aug 1970). (In Japanese).

The spectrophotometric method for determining ammonia nitrogen with thymol, which had been previously reported, has been successfully applied to the determination of as little as 3 ppM of

nitrogen in uranium metal and dioxide. The method is also useful for determining nitrogen in uranium nitride, carbonitride, and carbide. The absorbance per microgram of nitrogen was 0.00818 (molar absorptivity = 1.15×10^4) at 670 mμ by the following procedure. Metal, oxide, and carbide containing up to 0.8 g of uranium are dissolved with 20 ml of hydrochloric acid (6 M) and 5 ml of hydrogen peroxide solution (30%). The other samples are dissolved with 10 ml of hydrochloric acid and 5 ml of fluoboric acid (4%), and uranium is then oxidized with a few drops of hydrogen peroxide solution. After decomposition of excess hydrogen peroxide, the solution is evaporated to dryness on a water bath to remove excess acid, and the residue is dissolved with 40 ml of sodium citrate solution (25 wt/v%). The pH of the solution is adjusted to 9.8–10.3 with sodium hydroxide solution (2 M) and 2 ml of sodium hydrogen carbonate (0.06 M)–sodium carbonate (0.075 M) buffer solution. Then, 0.5 ml of sodium hypochlorite solution containing 0.3% active chlorine is added with stirring. After 20 seconds, 2.5 ml of a freshly prepared mixture of the equal volumes of thymol solution (10% in acetone) and sodium hydroxide solution (1 M) is added. After addition of 4 ml of acetone, the resultant solution is transferred to a 100 ml measuring flask and diluted to the mark with water. After standing 1.5 hours in darkness, the absorbance of the colored solution is measured against the blank at 670 mμ. (auth)

43954 SIMULTANEOUS DETERMINATION OF ALUMINUM AND IRON IN PLUTONIUM. Motojima, Kenji; Yamamoto, Tadashi; Muto, Hiroshi; Kato, Yoshiharu (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 19: 1091-3(Aug 1970). (In Japanese).

A spectrophotometric method is described for determination of both aluminum and iron in the presence of plutonium. Plutonium is removed from nitric acid solution by extraction with tributyl phosphate. After masking any residual plutonium with hydrogen peroxide, oxinates of aluminum and iron are extracted with chloroform at pH 4.6–5.2. The extract is washed with potassium cyanide solution to remove copper and nickel. Then, by measuring the absorbances of the organic phase at 390 and 470 mμ, aluminum and iron are determined. By this method, 4 μg of aluminum and 4 μg of iron in the presence of 1 g of plutonium can be determined. (auth)

43955 DETERMINATION OF MICROGRAM QUANTITIES OF TUNGSTEN IN IRON, MOLYBDENUM, AND TITANIUM BY X-RAY FLUORESCENCE ANALYSIS. Maeda, Fujio; Hayasaka, Toyoo (Tohoku Univ., Sendai). Jap. Anal.; 19: 1036-40(Aug 1970). (In Japanese).

A method for the determination of microgram quantities of tungsten in iron, molybdenum, and titanium by x-ray fluorescence analysis is described in which tungsten is separated from the matrix metals by phenylfluorene with germanium as the coprecipitant after molybdenum and titanium have been masked with EDTA and hydrogen peroxide, respectively. The precipitation was done most successfully in 1% sulfuric acid or hydrochloric acid, and the precipitate was collected on a membrane filter. The recommended method was more rapid and sensitive than other chemical and spectrographic methods. (auth)

43956 DETERMINATION OF ^{13}C BY INFRARED SPECTROPHOTOMETRY OF CARBON MONOXIDE. McDowell, Robin S. (Los Alamos Scientific Lab., N. Mex.). Anal. Chem.; 42: 1192-3(Sep 1970).

The R(13) lines in the vibrational fundamentals of ^{12}CO and ^{13}CO occur at 2193 and 2144 cm^{-1}, respectively, and were selected as being sufficiently free from interference to serve for the determination of the $^{13}C/^{12}C$ ratio. From the theory of line intensities and a consideration of the effect of spectrometer resolution on the line shape, one can establish that $^{13}C/^{12}C = 1.023\ (s'A'/sA)^2$, where s is the spectral slit width, A is the peak absorbance, and the primed quantities refer to ^{13}CO. A series of analyses on samples with $^{13}C/^{12}C$ in the range 0.01 to 0.20 gave results which agreed to within about 2% of mass spectrometric determinations and had relative standard deviations of about 6%. (auth)

43957 X-RAY EXCITED OPTICAL FLUORESCENCE SPECTROMETRY. SCOPE OF APPLICATION TO TRACE RARE EARTH DETERMINATIONS. DeKalb, Edward L.; D'Silva, Arthur P.; Fassel, Velmer A. (Ames Lab., Iowa). Anal. Chem.; 42: 1246-52(Sep 1970).

X-ray excited optical fluorescence spectrometry was used for detecting the presence of rare earth impurities at concentrations of 100 ppM or less in compounds prepared from 49 of the chemical elements. Several of the more complex compounds provided detectabilities superior to the simple oxides. The excitation mechanism for production of these spectra is reviewed. (auth)

43958 FLUOROMETRIC DETERMINATION OF SUBMICROGRAM QUANTITIES OF THORIUM. Filer, T. D. (Health Services Lab., Idaho Falls, Idaho). Anal. Chem.; 42: 1265-7 (Sep 1970).

3,4',7-Trihydroxyflavone was studied for use in the fluorometric determination of thorium. The effects of various substances are tabulated. The procedure was found to have advantages over the traditional thorin procedure in that beryllium at natural levels does not interfere. (auth)

43959 SPECTROPHOTOMETRIC METHOD FOR THE ESTIMATION OF RUTHENIUM CONTENT IN RUTHENIUM PLATING SOLUTIONS. Boose, C. A.; Reidt, M. J. TNO Nieuws; 24: 27-30(Jan 1969).

A spectrophotometric method for analyzing complexed ruthenium is described. The method is suitable for a minimum ruthenium content of 0.1 mg/l. The valency state of the ruthenium does not influence the determination. Nitrosyl groups or strong complexing acids in the sample must be decomposed before distillation with perchloric acid. Color is developed with thiourea between 80 and 90°C. The accuracy of the method is within 5%. (auth)

Radiometric Procedures

Refer also to abstracts 44061, 44062, 44123, 44222, 44236, 44240, 44273, and 44394–44399.

43960 (CEA-N-1292, pp 107-12) AUTOMATION TESTS CARRIED OUT AT THE HEALTH PROTECTION DEPARTMENT, HEALTH CONTROL SECTION. Jeanmaire, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

When testing the radioactivity of the food chain it is necessary to work at an activity level of the order of a few picocuries, which means using large test samples and carrying out purifications to remove inactive matter. In addition certain analyses are performed in large series and an effort has been made towards automation. Three units were built: a liquid–liquid extractor for ^{90}Sr determination in milk; an apparatus to mineralize urine and obtain an alkaline-earth phosphate residue for Pu determination; and an apparatus to measure Pu by the use of ion exchange resins. These 3 units include components specific to each, and a common operational control device. (France)

43961 (CEA-N-1292, pp 113-29) CONTRIBUTION OF THE GENERAL ELECTRONICS DEPARTMENT TO THE DEVELOPMENT OF CAPTORS FOR ROUTINE ON-LINE ANALYSIS. Edeline, J. C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

Present work is concerned particularly with the routine analysis of solutions to measure the concentrations of some fissile materials by detection of the α particles emitted, and some heavy elements such as U, Pu, Th. For the former problem an apparatus containing a semiconductor detector was designed to obtain precise spectra of the charged particles and to attempt an electronic separation of the different α emitters present in the solution. For the second, the following 3 types of γ absorptiometer were built: ionization chamber type for industrial measurements in the presence of γ emitters (50 to 600g/l U); PM type for industrial measurements without γ emitters; PM type for laboratory measurements without γ emitters. (France)

43962 (CEA-N-1292, pp 131-7) ON-LINE ANALYSIS AT THE A.T.M. Bouzou, M.; Fontaine, A. (Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

At the tritium plant it is possible to carry out gas analyses at any moment, to check either the impurity content or the isotopic composition. Two chromatographs and a mass spectrometer are assigned to the supervision of the first two stages of the process (fusion of Al–Li pencils and purification of fusion gases). Two more chromatographs are placed on the thermal diffusion lines to test gases either at the diffusion column input, or before or after the last palladium cell. (France)

43963 (CNEA-265) DETERMINATION OF FREE ^{99m}Tc IN LABELED COMPOUNDS BY MEANS OF THIN LAYER CHROMATOGRAPHY. Mitta, Aldo E. A.; Cervera, Jorge Alvarez; Raban, Pavel (Comision Nacional de Energia Atomica, Buenos Aires

(Argentina)). 1970. 10p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

A method for the determination of the radiochemical purity of the most frequently used ^{99m}Tc labeled radiopharmaceutical is described. The use of a scintillation counter is proposed for the radiometric evaluation of the chromatograms. The radiochemical purity can thus be established 5 to 30 minutes after the compound is prepared. (auth)

43964 (HASL-217, pp I.130-48) ANALYSES OF QUALITY CONTROL SAMPLES AT HASL AND A CONTRACTOR LABORATORY DURING 1969. Hardy, E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program Quarterly Summary Report.

A summary of quality control data for bone ash, milk ash, vegetation ash, ion exchange resin, and simulated pot samples analyzed during 1969 at Health and Safety Laboratory are presented. (D.H.M.)

43965 IMPROVEMENTS IN AND RELATING TO A DEVICE FOR SAMPLING PARTICLES IN A GAS. Lasseur, Claude; Tonnelier, Claude; Zerbib, Jean-Claude (to Commissariat a l'Energie Atomique). British Patent 1,195,603. 17 Jun 1970. Priority date 31 Jan 1967, France.

A device for sampling particles in a gas includes a sampling chamber, a discharge chamber, and a filter. The sampling chamber is provided with a gas inlet, and the discharge chamber includes both a gas inlet closed by the filter and gas outlet and defines with the sampling chamber an annular space through which the gas will flow in passing from the inlet of the sampling chamber to the inlet of the discharge chamber. Fins are radially disposed in the annular space to provide laminar flow of the gas upstream of the filter. The device is particularly applicable to sampling of radioactive particles in the atmosphere. (B.L.M.)

43966 APPARATUS FOR MEASUREMENT OF CONCENTRATION IN THE ATMOSPHERE OF THE SHORT-LIVED SOLID DECAY PRODUCTS OF RADON. Lasseur, Claude (to Commissariat a l'Energie Atomique). British Patent 1,191,982. 13 May 1970. Priority date 13 Apr 1967, France.

An apparatus for measuring the concentration in the atmosphere of short-lived solid elements resulting from the decay of Rn comprises a sampling tube transversed by a movable filter strip and detectors. The sample tube is open at one end and is connected at the other end to a pumping device through an electrovalve. An α detector and a β detector are placed in oppositely facing relation with one detector above the strip and one below it. Both detectors are placed at a predetermined distance from the sampling tube. Cyclic control means accuate the electrovalve to commence sampling period and then initiate the movement of the strip-moving system after a given sampling time. The strip-moving system is stopped when that portion of the strip present within the tube during the sampling period is located at the position of the detectors. Electrical circuitry is provided for collecting, recording, and subtracting the signals from the various elements to give a measure of each individual element. (B.L.M.)

43967 MEASUREMENT OF LOW LEVELS OF ^{131}I IN REACTOR ATMOSPHERES. Furtado, V. C.; Kneip, T. J.; Eisenbud, M. (New York Univ. Medical Center, N. Y.). Nucl. Appl. Technol.; 9: 268-73(Aug 1970).

A system was designed to evaluate MPC level concentrations of ^{131}I in reactor environments. The system provides reliable determinations of total ^{131}I concentrations even under such unfavorable sampling conditions as high relative humidity or very low concentrations. Furthermore, the fraction of methyl iodide present can also be determined from the activity distribution on the several parts of the system. Field experiments were conducted at Consolidated Edison's Indian Point No. 1 reactor. The results of these tests are presented and discussed. (auth)

43968 DETERMINATION OF THE CONCENTRATION OF VOLATILE ISOTOPES IN BLOOD BY LIQUID SCINTILLATION COUNTING. Smith, A. L.; Thomas, J. W.; Wollman, H. (Univ. of Pennsylvania, Philadelphia). Int. J. Appl. Radiat. Isotop.; 21: 171-5(Mar 1970).

A straightforward method for liquid scintillation counting of gaseous radioactive substances dissolved in blood is described. It was successfully applied to ^{85}Kr and to ^{14}C labeled volatile substances, and should be applicable to other isotopes in blood. The method gives high efficiency with 0.5 ml blood samples and utilizes commercially available automatic counting apparatus. The scintillation medium consists of 60% tolerance and 40% Triton X-100 v/v plus 5g/l PPO and 0.5g/l dimethyl POPOP. If the absolute activity per sample is required internal standards are prepared. Reproducible results can be obtained with a minimum of practice. Selection of scintillator solution, choice of counting parameters, quench correlations, breakage of gas, counting efficiencies and partitioning, and precision are discussed. (UK)

43969 DETERMINATION OF ^{131}I ACTIVITY DIRECTLY AFTER A REACTOR PERTURBATION EVENT. Funsch, B. (Landesinstitut fuer Arbeitsschutz und Arbeitsmedizin, Karlsruhe, Ger.). Naturwissenschaften; 57: 241(May 1970). (In German).

Within the first few hours after accidental release of fission products, determination of ^{131}I presents difficulties because of the presence of ^{133}I. The ratio of ^{131}I to ^{133}I is characteristic for each nuclear installation and, therefore, should be determined. Activity of ^{133}I can be measured at the 1.24-MeV peak and, thus, ^{131}I activity inferred. Approximately 15 to 30 hours after accidental release, ^{131}I activity can be determined directly through γ-spectrometry. (H.B.G.)

Activation Procedures

Refer also to abstracts 45715 and 45757.

43970 (COO-1705-6) NONDESTRUCTIVE ACTIVATION ANALYSIS OF ENVIRONMENTAL SAMPLES. Special Report No. 48. Dams, Richard; Robbins, John A. (Michigan Univ., Ann Arbor. Great Lakes Research Div.). May 1970. Contract AT(11-1)-1705. 101p. Dep. CFSTI.

The general principle of activation analysis is discussed, along with the procedure for nondestructive activation analysis of environmental samples, including apparatus, identification of isotopes-qualitative analysis, quantitative analysis of Ge(Li) spectra, irradiation-counting scheme, sensitivity-detection limits, possible interferences, and neutron flux mapping. Special attention is given to computerized data reduction, including tape analysis, data analysis programs, base spectrum calculation and peak integration, plotting, peak search routing, component identification, nonlinear least squares program, and composite program. No specific analyses are described. (P.C.H.)

43971 DISTRIBUTION OF Mn AND Br IN AN URBAN AREA AS REVEALED THROUGH ACTIVATION ANALYSIS. Randerson, Darryl (Texas A and M Univ., College Station). Atmos. Environ.; 4: 249-57(May 1970).

Fifteen high-volume samplers were operated continuously for 24-hr periods in Houston, Texas, and filter papers from one day of sampling were irradiated in a thermal neutron flux and the resulting radionuclides were identified. Among elements detected were Mn and Br. During one 24 hr period the concentrations of Mn ranged from 0.02 to 0.56 $\mu g\ m^{-3}$ while those of Br ranged from 0.04 to 1.09 $\mu g\ m^{-3}$. The spatial distributions of these two elements were related to the meteorological conditions. The patterns of concentration appeared to be related to the predominant direction of the wind. The primary source of the Mn is considered to be from industrial effluvia. It is proposed that the Br may have originated as particulates contained in the exhaust gases from motor vehicles. (auth) (UK)

43972 NEUTRON ACTIVATION ANALYSIS OF RESIDUAL OIL FOR VANADIUM. Flaherty, John P.; Eldridge, H. B. (Univ. of Wyoming, Laramie). Appl. Spectrosc.; 14: 534-8 (Sep-Oct 1970).

Neutron activation analysis is investigated as a nondestructive method of analyzing large residual oil samples for vanadium content in the 20 to 2000 ppM range. For a flux of 10^8 neutrons/$cm^2 \cdot$sec, a 10 min analysis of a 3 g oil sample can yield concentration measurements that are reproducible to within a maximum deviation of 7% for a wide latitude of experimental conditions with no sample preparation. The adaption of neutron activation analysis herein investigated has several features that make it attractive as a means of on-line process control in petroleum cracking plants. (auth)

43973 DETERMINATION OF MAJOR AND TRACE ELEMENTS IN SOILS FORMED ON MATADI GREEN ROCKS. van Compernolle, G. (Univ., Lovanium, Kinshasa, Congo); Krivanek, M.; Masozera, C.; Lumu, F. R. pp 69-72 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The identification and determination of the minerals present in soils and in the rocks on which such soils are formed can be of help in determining the fertility of the soil and the amount of fertilizer required. Insofar as they relate to trace elements, these data are of great importance for agriculture and animal husbandry since any excess or deficiency can have an adverse

effect on animal and plant growth. Most of the major elements, notably aluminum, silicon, manganese, sodium, and potassium can be easily measured. However, determination of iron by the $Fe(n,p)^{56}Mn$ reaction is not possible owing to the large manganese content of the samples. For trace element determinations recourse must be had to chemical separation. (auth)

43974 DETERMINATION OF ALUMINUM AND SILICON IN THE ARGILLACEOUS FRACTION OF CONGOLESE SOILS. Masozera, C.; van Compernolle, G.; Pollak, H.; Roels, J. (Centre Nucleaire TRICO, Kinshasa, Congo). pp 73-82 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Measurements of aluminum and silicon reveal the nature of clay soils and their degree of crystallization. This information, together with other data, makes it possible to identify the type of soil under consideration. The samples are first treated by the Jackson-Hashimoto method: heating to various temperatures followed by dissolution in NaOH (0.5N). The method is nondestructive and simple to use owing to the short half-life and large concentration of the aluminum produced. In the present case the aluminum measurements involved the use of thermal neutrons, the silicon measurements that of fast neutrons. The measurements are made by gamma spectrometry with a 400-channel analyzer. The results are recorded by an automatic printer. (auth)

43975 MEASUREMENT AND STUDY OF THE SELF-DIFFUSION OF TRANSITION ELEMENTS IN 13X AND 5A ZEOLITES. Mulkay, P. (Univ. of Lovanium, Kinshasa, Congo); Roels, J. pp 537-41 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Cobalt, manganese, and nickel were determined in 13X zeolite by neutron activation and self-diffusion of cobalt in 5A zeolite was studied. Ion exchange revealed the following order of selectivity: Co ≥ Mn > Ni. For the self-diffusion study, cobalt activated by neutron bombardment was adsorbed in suitable quantities on the zeolite, which was previously charged with natural cobalt by ion exchange. The measurements were carried out by gamma spectrometry. The activation energy for self-diffusion was determined from the linear plot of $\log_{10} D$ versus $1/T$ °K, using the Arrhenius equation. A value of 13.4 kcal/deg/ion g was found. The values obtained were compared with those for other divalent cations. (auth)

43976 RARE EARTHS IN THE HUMAN BODY. I. YTTRIUM. Eraemetsa, Olavi; Sihvonen, Marja-Liisa; Forssen, Anja (Technical Univ., Otaniemi, Finland). Ann. Med. Exp. Biol. Fenn. (Helsinki); 46: 179-84(1968).

The distribution of rare earths, was studied in the human body using neutron activation and x ray fluorescence analyses. Autopsy specimens were taken from patients who had died in the medical wards of municipal hospitals in Helsinki. Yttrium was present (0.003% of the ash) in 61 out of the 236 specimens representing 28 different organs. In 10 organs no yttrium was detected. In 37 of the 80 individuals studied, yttrium was present in several organs. There was great individual variation in the amounts present and the organs involved. The highest content found in this study was 0.670% of the ash. The patients were divided into four groups, according to the cause of death; diseases of blood vessels, infections, tumors and other diseases. In all these groups both positive and negative results were obtained in tests for yttrium. No marked differences were noted between males and females or between different age groups. (auth)

43977 SIMULTANEOUS DETERMINATION OF PHOSPHORUS AND CHLORINE IN PHOSPHOROORGANIC COMPOUNDS BY ACTIVATION WITH FAST NEUTRONS. Lisovskii, I. P.; Smakhtin, L. A. (Physico-Chemical Inst., Moscow). Zh. Anal. Khim.; 25: 1625-8(Aug 1970). (In Russian).

The simultaneous determination of P and Cl in phosphoorganic compounds was found to be possible. The effects of chlorine on the results of phosphorus determination were studied. (auth)

43978 RAPID DETERMINATION OF SODIUM IN PHOSPHOROORGANIC COMPOUNDS BY THE METHOD OF ACTIVATION WITH FAST NEUTRONS. Lisovskii, I. P.; Smakhtin, L. A. (Physico-Chemical Inst., Moscow). Zh. Anal. Khim.; 25: 1629-31(Aug 1970). (In Russian).

The rapid (3 to 4 min) determination of macroamounts of sodium in phosphoroorganic compounds can be carried out by means of the reaction $^{23}N(n,p)^{23}Ne$. The determination of isotopes with a gamma-ray quantum energy close to 0.51 MeV on the background of positron emitters in a well-crystal is possible. (auth)

43979 THEORY OF SUBSTOICHIOMETRIC SEPARATION OF ELEMENTS. COMMUNICATION 6. SUBSTOICHIOMETRIC SEPARATION BY PRECIPITATION. Perezhogin, G. A. Zh. Anal. Khim.; 25: 1445-9(1970). (In Russian).

The possibility of substoichiometric separation by precipitation depends on the ratio between the solubility product, the stability constant of the complex (for non-electrolytes), the accuracy of separation needed, and the concentration of the separated element. The effect of competing elements has been studied. Substoichiometric separation by precipitation can be used in radioactivation analysis for the determination of fluorine, chlorine, bromine, sulfur, selenium, and some other elements. (auth)

43980 ACTIVATION ANALYSIS OF IMPURITIES IN SEMICONDUCTOR SI. Takagi, Takashi (Mitsubishi Electric Corp., Amagasaki, Japan); Ikeda, Hiroshi; Sugioka, Yasoichi. Mitsubishi Denki Giho; 44: 938-45(Jul 1970). (In Japanese).

The electric performance of semiconductor silicon depends on the kinds and content of impurities in it and varies a great deal. It is no exaggeration to say that semiconductor engineering is the high grade technique of being able to introduce the impurities in the material to obtain necessary electric performance. The analysis of impurities is one of the most important basic techniques in controlling the introduction of impurities; high sensitivity and high reliability are needed. Thermal neutron activation analysis (nondestructive) has been applied to the determination of impurities in semiconductor Si as a non-destructive method. The method is described. The impurity elements determined were Sb, As, Au, and Na. (auth) (Japan)

43981 DETERMINATION OF CHEMICAL COMPONENTS AT THE ppB LEVEL IN BOTH POLAR SNOW STRATA. I. NEUTRON ACTIVATION ANALYSIS OF CHLORINE IN ARCTIC AND ANTARCTIC SNOW STRATA. Murozumi, Masayo (Muroran Inst. of Tech., Japan); Patterson, Clair C. Jap. Anal.; 19: 1049-56(Aug 1970). (In Japanese).

A minute amount of chlorine ($n \times 10 \sim n \times 10^2$ μg/kg) in melted snow can be determined by a neutron activation method, whose accuracy is within 10% error covering above concentration range with sensitivity 0.006 μg. This method can distinguish Antarctic snow from the other, measure the distribution of the element in the interior snow strata, and also detect yearly and seasonal variations of snow character. (auth)

43982 DETERMINATION OF CHEMICAL COMPONENTS AT THE ppB LEVEL IN BOTH POLAR SNOW STRATA. II. DETERMINATION OF SODIUM IN ARCTIC AND ANTARCTIC SNOW STRATA: COMPARISON BETWEEN NEUTRON ACTIVATION ANALYSIS AND ATOMIC ABSORPTION ANALYSIS AFTER APPLICATION OF FREEZING CONCENTRATION TO SAMPLES. Murozumi, Masayo (Muroran Inst. of Tech., Japan); Nakamura, Seiji; Patterson, Clair C. Jap. Anal.; 19: 1057-63(Aug 1970). (In Japanese).

Neutron activation of nuclides can be applied to the measurement of sodium components at the ppB level in liquid samples by irradiating ^{23}Na with thermal neutrons to form ^{24}Na. The detection limit of the element by this method is 0.5 ppB and the accuracy is ±5% relative error. Sodium concentration in both polar snow strata has been found to be between 5 and 40 ppB, which is affected by yearly and seasonal atmospheric conditions. Sodium ions at such concentration levels can also be quantitatively determined by atomic absorption spectroscopy after application of successive freezing concentration to the samples, sodium ions being enriched in the liquid phase but not in the ice phase. The overall detection limit by this method is 0.5 ppB and the accuracy is ~10% relative error, sodium components in fine particles such as volcanic ashes and clays being occluded, unlike sodium ions, in ice phase. (auth)

43983 MUSCLE COPPER, ZINC, AND MANGANESE LEVELS IN WILSON'S DISEASE: STUDIES WITH THE USE OF NEUTRON-ACTIVATION ANALYSIS. Leu, M. L.; Strickland, G. T.; Beckner, W. M.; Chen, T. S. M.; Wang, C. C.; Yeh, S. J. (National Tsing Hua Univ., Taipei, Taiwan). J. Lab. Clin. Med.; 76: 432-8(Sep 1970).

Fourteen patients with Wilson's disease, 10 of their parents and siblings, and 12 control subjects had muscle copper, zinc, and manganese concentrations determined by the use of neutron-activation analysis. Zinc and manganese concentrations did not differ significantly in the 3 groups. Although patients with Wilson's disease had a significant ($p < 0.05$) increase in mean muscle copper concentration when compared with that of control subjects, there was too much overlap for this to be a useful diagnostic test. Ten of the 14 patients with Wilson's disease were estimated to have an increased amount of copper in their muscle tissues, averaging 4.5 mg. This amount of copper is small when compared with the excess copper in the liver and central nervous system of patients

with Wilson's disease and suggests that the muscle is only a secondary site for deposition of copper. (auth)

43984 USE OF A (d,T)-NEUTRON GENERATOR FOR ACTIVATION ANALYSIS. PRACTICAL METHODS FOR CHEMICAL MATERIALS TESTING. Neider, R.; Reimers, P.; Santer, E.; Schmitt, B. F. (Bundesanstalt fuer Materialpruefung, Berlin). Atomwirt., Atomtech.; 15: 382-5(Aug 1970). (In German).

Activation analysis was performed with a (d,T) generator that produced 14-MeV neutrons. Nondestructive analyses were performed for oxygen, silicon, silver, and copper in metals. Experience showed that present equipment within certain limits of accuracy, can be applied successfully for control of industrial processes and for purity of gold coins. Before large-scale operation in industry is possible, however, further improvement of the neutron generator is mandatory, especially as to reproducibility of the neutron beam. (H.B.G.)

43985 YIELDS OF ^{18}F ON IRRADIATING SODIUM, MAGNESIUM, AND ALUMINUM WITH ^{3}He IONS AND ON IRRADIATING SODIUM WITH ALPHA PARTICLES. Krasnov, N. N.; Dmitriev, P. P.; Dmitrieva, Z. P.; Konstantinov, I. O.; Molin, G. A. At. Energ. (USSR); 28: 257(Mar 1970). (In Russian).

Oxygen impurity in metals and alloys is determined in most cases from the amount of ^{18}F activity which is formed from oxygen by irradiating with ^{3}He ions. However, ^{18}F can also be formed by irradiating Na, Mg, and Al with ^{3}He ions. The extent of contribution to the ^{18}F activity from these metals was determined by irradiating these metals in a ^{3}He cyclotron with particles. The particle energy was varied by the interposition of thin foils. Al and Mg were annealed in a hydrogen furnace to eliminate oxygen impurities. With 25 MeV ^{3}He particles the ^{18}F yields were 42, 1, and 1×10^{6} disintegrations/sec-microampere · hr for Na, Mg, and Al. With alpha particles bombarding sodium the ^{18}F yields were even smaller. The possibility of forming ^{18}F from these elements should be taken into account and corrected for, when determining oxygen impurity by irradiation with ^{3}He ions. (TTT)

43986 ACTIVATION ANALYSIS BY PULSED CYCLOTRON BEAMS. Chen, N. S.; Fremlin, J. H. (Birmingham Univ., Eng.). Nucl. Instrum. Methods; 85: 61-7(1 Aug 1970).

The feasibility of using short-lived isotopes and isomers produced by pulsed cyclotron beams in activation analysis was studied. The principles and methods were illustrated successfully by the measurement of $^{20}F(T_{\frac{1}{2}} = 11.2\ s)$ and $^{24m}Na(T_{\frac{1}{2}} = 20\ ms)$. The advantages offered and the problems faced in using this technique are discussed. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 43943, 43947, 44026, 44038, 44056, 44079, 44089, 44766, 44785, and 45365.

43987 (AECL-3514) EXPERIMENTAL INVESTIGATION OF THE ISOBARIC SPECIFIC HEAT OF HEAVY WATER. Rivkin, S. L.; Egorov, B. N. Translated by P. Z. Rosta (Atomic Energy of Canada Ltd., Sheridan Park, Ont.), from Paper E.7 of the Proceedings of the Seventh International Conference on the Properties of Steam, Tokyo, 1968. 29p. (CONF-680979-1). Dep. CFSTI (U. S. Sales Only).

An investigation of the isobaric specific heat of heavy water was carried out using flowing adiabatic calorimeters. Two sets of experimental apparatus were constructed on this principle, utilizing closed circulating circuits. The heat capacity was measured in the liquid phase on the 50, 100, 150, 200, 225, and 250 kgf/cm^2 isobars at temperatures up to 370°C, in the vapor phase on the 150, 175, and 200 kgf/cm^2 isobars at temperatures up to 450°C and in the supercritical region on the 225, 240, 250, 260, 275, and 300 kgf/cm^2 isobars at temperatures from 330 to 450°C. 225 points were obtained for the stated parameters. The methods of investigation and the experimental apparatus are described, and the tables of experimental data are given. (auth)

43988 (ANL-7650) CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS, JANUARY-DECEMBER 1969. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 79p. Dep. CFSTI.

Progress is reported under the following headings: fuel-cycle technology; sodium technology; materials chemistry and thermodynamics; analytical and reactor chemistry; chemistry of liquid metals and molten salts; and fluidized-bed combustion of fossil fuels. A separate abstract was prepared for each of the 6 sections. (M.C.G.)

For abstracts of individual sections see: 43935, 43989-43992, and 44060.

43989 (ANL-7650, pp 15-22) SODIUM TECHNOLOGY. (Argonne National Lab., Ill.).

Topics covered include: sodium chemistry; sampling and analysis; sodium purification and monitoring; fission product behavior and control; cover-gas studies; and materials compatibility. (M.C.G.)

43990 (ANL-7650, pp 23-34) MATERIALS CHEMISTRY AND THERMODYNAMICS. (Argonne National Lab., Ill.).

Topics covered include: volatilization studies of plutonium compounds by mass spectrometry; phase diagram of the U-Pu-O system; equilibrium studies of U-fission product-O systems; transpiration studies of the U-C system; enthalpies and heat capacities by drop calorimetry; other studies of physical properties; segregation in ceramic fuels; enthalpy of formation of UB_2 and PuC; thermochemistry of HF; chemical bonding in NSF_3, NSF, and NS_2; enthalpy of formation of MoS_2; thermochemistry of aqueous xenon trioxide; enthalpies of formation of $KBrO_4$ and $KBrO_3$; and thermodynamic properties of perbromate and bromate ions. (M.C.G.)

43991 (ANL-7650, pp 41-66) CHEMISTRY OF LIQUID METALS AND MOLTEN SALTS. (Argonne National Lab., Ill.).

Topics covered include: thermodynamics of liquid metals; electric conductivity of selenium- and sulfur-containing cathode alloys; phase diagrams of lithium halide-containing systems; structure investigations by spectroscopic methods; lithium/chalcogen cells; immobilization of fused-dalt electrolytes; materials stability; high-specific-energy lithium/selenium batteries for implantation; high-specific-power lithium/selenium cells for vehicle propulsion; lithium/sulfur cells for vehicle propulsion; and performance comparison. (M.C.G.)

43992 (ANL-7650, pp 67-8) FLUIDIZED-BED COMBUSTION OF FOSSIL FUELS. (Argonne National Lab., Ill.).

Bench-scale experiments on the fluidized-bed combustion of fossil fuels were conducted at a combustion temperature of 1600°F and a superficial gas velocity of 3 ft/sec. The presence of limestone additive reduced the emission of SO_2 by 29 to 87%. (M.C.G.)

43993 (NP-18248) STUDIES ON URANYL CHLORIDES. Mirel, Constantin (Academia R. S. R., Cluj. Institutul de Chimie). 1968. 18p. (In Rumanian). Dep. CFSTI (U. S. Sales Only). Thesis.

After a survey of studies on uranyl chlorides up to 1967, experiments on new methods for the preparation of these compounds are presented. The trichloride, given in the literature as $UO_2Cl_2 \cdot HCl \cdot H_2O$ may be considered a tetracoordinated compound $[UO_2Cl_3H_2O] \cdot H \cdot H_2O$. Ratios of $UO_2^{2+} : Cl^- = 1:4$ are often encountered but the existence of ratios of 1:5 and 1:6 have not yet been proved. Chlorination of UO_3 in organic media possessing a low dielectric constant, such as CS_2, CCl_4, $CHCl_3$, or n-pentane, yielded $UO_2Cl_2 \cdot H_2O$; this is a convenient method for preparing this monohydrate. The operation in other solvents, CH_3OH, C_2H_4OH, C_3H_6O or $(C_2H_5)_2O$, yielded solvates of $UO_2Cl_2 \cdot H_2O$. A new compound, $UO_2(CH_3COO)_2 \cdot 2HCl$, was obtained by chlorinating $UO_2(CH_3COO)_2$ in low dielectric constant solvents. Removal of HCl from $UO_2(CH_3COO)_2 \cdot 2HCl$ takes place at two different temperatures, indicating that the two HCl molecules are not bound in the same manner. A study of the infrared spectra indicated that regardless of the method used to prepare UO_2Cl_2, the frequencies of the symmetric and asymmetric vibrations lie in the same range, disproving Duval's statement that these frequencies should be attributed to the $[UCl_6]^{3-}$ group. In the extraction with TBP and TEP, the excess chlorides exert a positive effect on the partition coefficient through a mechanism involving the dehydration of the medium and the common ions. Twenty-four different tetrachlorides were synthesized, 10 for the first time; thermal decomposition of these salts revealed that water is weakly bound and may be removed by an endothermic process. (TTT)

43994 (ORNL-4543) BEHAVIOR OF IODINE IN ZIRCALOY CAPSULES. Feuerstein, Horst (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 37p. Dep. CFSTI.

The behavior of iodine in Zircaloy capsules under conditions similar to those on the inner cladding surface of a fuel rod in water-cooled reactors was investigated. The thermodynamic equilibrium in the system was attained over the following reaction chain: chemisorption of the iodine on the metal surface, reaction of the chemisorbed iodine with the metal to form ZrI_4, chemisorption of the ZrI_4 on the metal surface, and reaction of the chemisorbed ZrI_4 with the metal to form lower iodides. For equilibrium conditions the experimental results do not agree with

thermodynamic calculations. The results can be explained by assuming different intermediate phases of zirconium iodides at different temperatures. (auth)

43995 (ORNL-TM-3062) AQUEOUS-PHASE DECOMPOSITION OF TRIBUTYL PHOSPHATE AT 35 TO 75°C IN NITRIC ACID SOLUTIONS. Davis, W. Jr.; Kibbey, A. H. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 24p. Dep. CFSTI.

The decomposition of tributyl phosphate (TBP) dissolved in the aqueous phase was studied by heating two-phase systems of TBP with 1 to 5 M HNO_3 at 35 to 75°C and subsequently analyzing for decomposition products by a methylation–gas chromatographic method. Phase ratios were maintained in the range 50 to more than 10,000 volumes of aqueous solution per volume of separate TBP phase to assure that most of the decomposition occurred in the aqueous phase. The results are consistent with those obtained by extrapolating literature data at 75 to 115°C to the lower temperatures, and show that the rate constant for TBP decomposition in the aqueous phase is tenfold higher than that in the organic phase. However, in process applications, where the organic volume will equal or exceed the aqueous volume, the TBP decomposition rate in the organic phase will be one hundredfold higher than in the aqueous phase. The decomposition mechanism may not be as simple as a series of successive first-order reactions whereby hydrogen atoms replace butyl groups, or hydroxyl groups replace butoxy groups. (auth)

43996 (UCRL-19645) MASS SPECTROMETRIC STUDIES OF GASEOUS OXIDES OF RHENIUM AND OF THE LANTHANIUM TRIFLUORIDE DIMER. Skinner, Harry Bryant (California Univ., Berkeley. Lawrence Radiation Lab.). Jul 1970. Contract W-7405-eng-48. 65p. Dep. CFSTI.

Thesis.

Knudsen cell mass spectrometry was employed in three temperature ranges (327 to 463°K, 1047 to 1267°K, and 1770 to 2143°K) to study the major vapor species present in the rhenium–oxygen system. The sublimation of rhenium heptoxide was found to yield rhenium heptoxide gas according to the pressure-temperature relationship $\log P_{Re_2O_7} = [(7.437 \pm 0.081)(10^3/T) + (12.350 \pm 0.209)]$ where the pressure is in atmospheres. In addition, a small percentage of oxygen is evolved by incongruent vaporization according to the reaction $Re_2O_7(s) \rightarrow 2\ ReO_3(s) + 1/2\ O_2(g)$. Weight loss measurements yielded +13.204 ± 0.250 kcal for the enthalpy of the reaction at 298°K. Mass spectrometry of the vapors from the rhenium–zinc oxide reaction revealed evidence of $ReO_3(g)$ and $Re_2O_6(g)$. Measurement of the reaction of rhenium with zinc oxide as a function of temperature yielded values for the enthalpies of formation of $ReO_3(g)$ and $Re_2O_6(g)$ of −67.0 ± 3.5 kcal/mole and −209 ± 20 kcal/mole, respectively. Similar magnesium oxide–rhenium measurements confirmed the zinc oxide–rhenium measurements of the stability of $ReO_3(g)$ and permitted upper limits to the dissociation energies of ReO(g) and $ReO_2(g)$ to be established. Consideration of the data for each reaction argues against the presence of $Re_2O_5(g)$, $ReO_2(g)$ or ReO(g) as significant vapor species under any of the conditions of this study. Intensities of ion peaks attributable to $LaF_3(g)$ and $La_2F_6(g)$ were measured as functions of temperature in a mass spectrometric study of the equilibrium vapor of lanthanum trifluoride. The vaporization data for the monomer are in very good agreement with torsion-effusion data of Mar and Searcy. The heat of the reaction $La_2F_6(g) = 2LaF_3(g)$ is 71.3 ± 0.9 kcal/mole at 1577°K. The apparent entropy of sublimation of the dimer is about 11 eu/mole lower than expected from studies of aluminum halides. It is argued that the principal ion fragment produced from $La_2F_6(g)$ in the mass spectrometer is masked by that from $LaF_3(g)$ and that the partial pressure of $La_2F_6(g)$ is about 1% that of the monomer at 1575°K, a value about 100 times that calculated by conventional interpretation of the mass spectrometer data. (auth)

43997 HEAT CAPACITY OF URANIUM MONOSULFIDE FROM 300° TO 600°K. Nakai, Eiichiro; Ono, Futaba; Takahashi, Yoichi; Mukaibo, Takashi (Mitsubishi Metal Mining Co. Ltd., Saitama, Japan. Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 427-8(Aug 1970).

The heat capacities of uranium monosulfide (US) measured by means of an adiabatic calorimeter in the temperature range between 300 and 600°K are reported, and the results were compared with data by others. Treatment of the data by the least squares method yielded the equation $C_p = 11.31 - 3.683 \times 10^{-3}\ T - 3.144 \times 10^4\ T^{-2}$ (cal/mole · deg). This equation fitted the experimental data from 300 to 600°K with a mean deviation of 0.6%. The calculated heat capacities at 298.15, 400, and 500°K were 12.06, 12.59, and 13.03 (cal/mole · deg), respectively. (P.C.H.)

43998 ENTHALPY OF FORMATION OF TUNGSTEN SULFIDE WS_2. Degroise, Bernard; Oudar, Jacques (Ecole Nationale Superieure de Chimie, Paris). Bull. Soc. Chim. Fr.: No. 5, 1717-19(May 1970). (In French).

The standard free enthalpy of formation of WS_2 was determined from an investigation, using a radiochemical technique, of the gaseous equilibrium $1/2\ WS_2 + H_2 \rightleftharpoons 1/2\ W + H_2S$ within the temperature range 750 to 1000°. The composition of the gas phase was determined by measurement of sulfur-35 activity, which is proportional to the concentration of hydrogen sulfide in the gaseous mixture. Equilibrium constants were calculated for the various reaction temperatures. (J.G.B.)

43999 INCREASING MAXIMUM ENRICHMENT PROCESSING CAPABILITY THROUGH CRITICALITY CALCULATIONS. Dunaway, D. L. (National Lead Co. of Ohio, Cincinnati); Miller, G. P.; Johnson, W. A. Nucl. Appl. Technol.; 8: 482-7(Jun 1970).

A study was initiated to determine the highest ^{235}U enrichment that could be processed safely in a facility originally designed for refining natural uranium ores and concentrates. The equipment used in converting uranyl nitrate to uranium trioxide was determined to be the limiting factor. Calculations of neutron multiplication throughout the denitration cycle were made using data from the analysis of process material. It was determined that the maximum ^{235}U enrichment could be safely increased to 2.0% from the previous limit of 1.25% ^{235}U. Processing at the higher enrichment required slight changes in equipment to ensure against moderation of the material. (auth)

44000 THORIUM DIHYDROXYDIMANDELATE. Kovalenko, K. N.; Kazachenko, D. V. (Rostov State Univ., USSR). Zh. Neorg. Khim.; 15: 1523-6(Jun 1970). (In Russian).

Measurements of electric conductivity, pH, and thorium concentration in the thorium nitrate–sodium mandelate–water system showed that, at 90°C, an exchange reaction occurs chiefly with the formation of thorium dimandelate. The compound isolated, $Th(OH)_2(C_6H_5CHOHCOO)_2$, was soluble in methyl and ethyl alcohols, acetone, and dioxane; its dipole moment in dioxane was determined (2.8 D); spectra were recorded in the frequency regions from 1000 to 1750 and 2400 to 3500 cm^{-1}; and thermogravimetric analyses were carried out. The structure of the compound is discussed. (tr-auth)

44001 STABILITY OF TERNARY HETEROPOLY COMPLEXES IN AQUEOUS SOLUTIONS. Barkovskii, V. F.; Velikanova, T. V. (Ural State Univ., Sverdlovsk, USSR). Zh. Neorg. Khim.; 15: 1618-23(Jun 1970). (In Russian).

The behavior of phosphothorium molybdate complexes and phosphocerium molybdate complexes was studied by extraction and precipitation. On extraction of these two complexes by n-butyl and isoamyl alcohols, the ternary complex decomposes and the phosphomolybdate complex goes with the organic layer. These two complexes were also decomposed by the action of cesium salts and quinine. The results indicated the comparative weakness of the Me–O–Mo bond in the phosphate–metal–molybdate systems in relation to other tetravalent metal complexes. The stability of the complexes decreased in the series Nb > Ti > Zr > Hf > Ce > Th. (tr-auth)

44002 TRANSITIONS AND DIAGONALS IN THE MENDELEEV TABLE. Huyskens, P. (Univ., Louvain, Belgium). Ind. Chim. Belge; 35: 498-504(Jun 1970). (In Flemish).

The energy pattern of the various electronic orbitals is responsible for the periodicity of the properties of the elements. This order determines the electron-configuration of the free atoms. The similitude of the energies of given orbitals (f.i. 3d, 4s, and 4p) also influence their ability for hybridization at the time of the formation of bonds with other atoms and ligands. For the transition elements, the ligand-field theory provides an adequate basis for predicting quantitatively the color and the magnetic properties of the complexes. (auth)

44003 HYDROGEN EXCHANGE AS A PROBE OF CONFORMATION OF TOBACCO MOSAIC VIRUS AND ITS COAT PROTEIN. Budzynski, A. Z.; Fraenkel-Conrat, H. (Univ. of California, Berkeley). Biochemistry; 9: 3301-9(18 Aug 1970).

The kinetics of H–D exchange of TMV and of TMV protein at pD 7 were measured by infrared spectrophotometry. In the virus about 85 hydrogen atoms/protein monomer (containing 291 exchangeable hydrogen atoms) exchange extremely slowly ($T_{\frac{1}{2}}$ = 25,000 min) whereas in the protein about 53 exchange slowly with a rate comparable with that of other native proteins. The exchangeable hydrogen atoms of TMV protein were replaced by tritium during 1-week's exposure to $[^3H]H_2O$ at pH 8 to 9 at 4°, and the exchange-out was studied over a wide pH range. Around pH 4.5 where the protein is predominantly aggregated the exchange rate was minimal; in acid it was faster than at alkaline pH. The

extrapolated number of very hard to exchange hydrogen atoms was about 96/monomer between pH 2.6 and 5. TMV reconstituted from tritiated protein lost the isotope at pH 5.0 at a very slow rate, which was of the same order of magnitude as that of the protein aggregated to rods at that pH. Again 85 and 95 residues per monomer were almost nonexchangeable, respectively. It seems that about 5 moles of water/monomer can be found by the rods made of protein alone. While the gross structure of the protein coat in TMV and TMV protein rods is similar, native and reconstituted virus is less accessible to hydrogen exchange than the protein aggregated in the absence of RNA. When virus or protein rods were exposed to $[^3H]H_2O$ for 1 week at pH 5 most of the bound isotope was readily exchanged out, the kinetics resembling those for detergent-denatured protein. It appears that only the surfaces of the rods become labeled under these conditions, and that there the conformation is largely random. In TMV, the kinetics of exchange-in (D_2O) are similar to those of exchange-out ($[^3H]H_2O$). The similarity suggests that the slowly exchanging hydrogen atoms are most likely peptide hydrogen atoms. Sixty per cent of them are very hard to exchange (30% in α helices, the other 30% presumably engaged in subunit binding). Thirty to forty per cent of the peptide bonds are in randomly coiled conformation located near the surfaces of the rod. It appears that no water is bound by TMV and TMV protein particles in a manner to depress its exchange rate noticeably. (auth)

44004 KINETICS OF DEUTERIUM SESQUIOXIDE IN HEAVY WATER. Bielski, Benon H. J. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem.; 74: 3213-16(20 Aug 1970).

The kinetic properties of deuterium sesquioxide were studied in heavy water as a function of acidity and temperature. D_2O_3 decomposes to D_2O and O_2 by first-order kinetics with an activation energy of 17.5 kcal/mole in 0.01 M $DClO_4$. The species has a maximum half-life of 139 sec at 0° in 0.027 M $DClO_4$. The isotope effect on the rate of decay $\kappa_{H_2O_3}/\kappa_{D_2O_3}$ is 6. Long pulse experiments were carried out in which the concentration of sesquioxide was increased to 0.5 mmole. (auth)

44005 CATALYSIS OF AROMATIC HYDROGEN–DEUTERIUM EXCHANGE BY METAL HYDRIDES. Barefield, E. K.; Parshall, G. W.; Tebbe, F. N. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Amer. Chem. Soc.; 92: 5234-5(26 Aug 1970).

Catalysis of the exchange between D_2 and benzene by certain organometallic (Ir and Ta) hydrides is reported. It is postulated that catalysis is effected by oxidative addition of the C–H bond to a coordinatively unsaturated intermediate. (J.G.B.)

44006 CHARGE DISTRIBUTION BETWEEN METAL AND URANIUM IONS IN THE PEROVSKITE $Ba(M_{0.5}U_{0.5})O_3$ WITH M = Mn, Fe, Co, Ni. Kemmler-Sack, S. (Laboratorium fuer Anorganische und Analytische Chemie, Tuebingen, Ger.). Z. Anorg. Allg. Chem.; 369: 217-37(Oct 1969). (In German).

According to results of spectroscopic and magnetic measurements the charge distribution in ordered perovskites was found to be $Ba_2Mn^{3+}_{0.4}Mn^{4+}_{0.6}U^{5+}_{0.4}U^{6+}_{0.6}O_6$, $Ba_2Fe^{3+}U^{6+}O_6$, $Ba_2Co^{2+}U^{6+}O_6$, and $Ba_2Ni^{2+}U^{6+}O_6$. The properties of the mixed crystals $Ba_2Mn_{1-x}In_xUO_6$ and $Ba_2Fe_{1-x}M_xUO_6$ (M = Ga, In, Mg, Zn) are reported. At low temperatures the iron compounds are ferrimagnetic. (auth)

44007 CHEMISTRY OF THE URANYL GROUP. III. PREPARATION, PROPERTIES, AND CRYSTAL STRUCTURE OF THE ISOMORPHOUS PAIR $UO_2((C_2H_5)_2NCS_2)_2(C_6H_5)_3AsO$ AND $UO_2((C_2H_5)_2NCS_2)_2(C_6H_5)_3PO$. Graziani, R.; Zarli, B.; Cassol, A.; Bombieri, G.; Forsellini, E.; Tondello, E. (Univ., Padua. Laboratorio Chimica e Tecnologia dei Radioelementi, Padua). Inorg. Chem.; 9: 2116-24(Sep 1970).

Two monomeric complexes of formula $UO_2((C_2H_5)_2NCS_2)_2 \cdot L$ with L = $(C_6H_5)_3AsO$ and $(C_6H_5)_3PO$ were synthesized from $K[UO_2((C_2H_5)_2NCS)_3] \cdot H_2O$ and triphenylarsine and triphenylphosphine oxides, respectively. Infrared and electronic spectra are reported. The crystals are isomorphous and monoclinic and belong to space group $P2_1/n$, with Z = 4. Cell dimensions are a = 18.28 ± 0.01, b = 9.128 ± 0.005, c = 20.95 ± 0.01 Å, and β = 111° 18′ ± 10′ for $UO_2((C_2H_5)_2NCS_2)_2(C_6H_5)_3AsO$ and a = 18.32 ± 0.01, b = 9.16 ± 0.01, c = 20.97 ± 0.01 Å, and β = 111° 39′ ± 10′ for $UO_2((C_2H_5)_2NCS_2)_2(C_6H_5)_3PO$. The structures were solved by the heavy-atom method using three-dimensional film data and refined by least squares to final R values of 9.4 and 9.3% for the arsine and the phosphine analogs. The uranium atom is in a seven-coordinate, pentagonal-bipyramidal environment. The linear uranyl group is perpendicular to the plane which contains four sulfur atoms of two carbamate groups and the oxygen atom of the ligand at the corners of an irregular pentagon. (auth)

44008 STUDIES OF BORANES. XXVIII. REACTIONS OF HEXABORANE(12). Collins, Alva L.; Schaeffer, Riley (Indiana Univ., Bloomington). Inorg. Chem.; 9: 2153-6(Sep 1970).

Reactions of hexaborane(12) with liquid deuteriodiborane(6) at –30°C yielded 1,1,4,4-tetradeuteriohexaborane(12). Further reaction with liquid deuteriodiborane(6) at room temperature resulted in the complete deuteration of hexaborane(12). The proton magnetic resonance spectrum at 100 MHz contains evidence for two sets of nonequivalent protons in the two BH_2 groups present in the compound in contrast to only one set found in the 60-MHz spectrum. There is no evidence for boron exchange between hexaborane(12) and liquid ^{10}B-diborane(6) at –30°C. Hexaborane(12) was found to be moderately stable in the liquid phase at room temperature and in the gas phase at higher temperatures but decomposed rapidly in the liquid phase at 100°C. Trimethylamine and propionitrile gave diborane and pentaborane(9) derivatives when they reacted with hexaborane. (auth)

44009 STUDIES OF BORANES. XXIX. ISOTOPE STUDIES OF HEXABORANE(10). Odom, Jerome David; Schaeffer, Riley (Indiana Univ., Bloomington). Inorg. Chem.; 9: 2157-61 (Sep 1970).

The preparation of hexaborane(10) from octaborane(12) and deuterium oxide did not result in a molecule specifically labeled with deuterium. The hexaborane(10) deuterium oxide exchange reaction resulted in a hexaborane(10) molecule almost completely substituted with deuterium in the bridge positions while the hexaborane(10)–deuteriodiborane(6) exchange reaction exclusively exchanged the basal terminal protons. The molecule, which is substituted in the basal terminal positions, was heated at 50° for 0.5 hr and did not undergo intramolecular exchange; however, it was found that hexaborane(10) does undergo intermolecular exchange at room temperature involving only the basal terminal positions. A temperature dependency of the low-field doublet in the ^{11}B nmr spectrum of hexaborane(10) was found. (auth)

44010 PREPARATION AND PROPERTIES OF 2- AND μ-(HALOSILYL)PENTABORANES(9). Geisler, Thomas C.; Norman, Arlan D. (Univ. of Colorado, Boulder). Inorg. Chem.; 9: 2167-70(Sep 1970).

The reactions of 2-$SiH_3B_5H_8$ and μ-$SiH_3B_5H_8$ with BCl_3 and BBr_3 produce 2-$(ClSiH_2)B_5H_8$, μ-$(ClSiH_2)B_5H_8$, and 2-$(BrSiH_2)B_5H_8$, in high yield. The 2-$(ClSiH_2)B_5H_8$ and 2-$(BrSiH_2)B_5H_8$ can also be prepared from the aluminum halide catalyzed reactions of 2-$SiH_3B_5H_8$ with HCl and HBr, respectively. In all cases, halogenation occurs exclusively at the silicon atom. The new compounds have been characterized by elemental analyses and infrared, ^{11}B nmr, ^1H nmr, and mass spectral data. Deuterium exchange between DCl and 2-$SiH_3B_5H_8$ or 2-$(ClSiH_2)B_5H_8$, catalyzed by aluminum chloride, occurs at the apical, B(1), terminal position. (auth)

44011 INVESTIGATIONS ON SELENIUM COMPOUNDS. L. DONOR–ACCEPTOR COMPLEXES OF DIMETHYLSELENIUM OXIDE WITH METAL PERCHLORATES. Paetzold, R.; Bochmann, G. (Friedrich-Schiller Univ., Jena, Ger.). Z. Anorg. Allg. Chem.; 368: 202-10(Jul 1969). (In German).

Complexes of $(CH_3)_2SeO$ with the metal perchlorates $M(ClO_4)_2$ (M = Mn, Co, Ni, Cu, Zn, Cd, Mg), $M(ClO_4)_3$ (M = Cr, Fe), $AgClO_4$ and $UO_2(ClO_4)_2$ are reported. Complexes isolated, where [$(CH_3)_2SeO$ = DMSeO], are: $[M(DMSeO)_6](ClO_4)_2$ (M = Mn, Co, Ni, Zn, Cd, Mg); $[M(DMSeO)_6](ClO_4)_3$ (M = Cr, Fe); $[Cu(DMSeO)_4](ClO_4)_2$; $[Ag(DMSeO)_2]ClO_4$ and $[UO_2(DMSeO)_5](ClO_4)_2$. The shifts of the Se = O stretching frequencies in the complexes show that oxygen is the donor atom. By means of magnetic moments, visible reflection spectra, and ir data, the possible structures of the complexes are discussed. The spectrochemical parameters Dq and B were calculated and the positions of $(CH_3)_2SeO$ in the spectrochemical and the nephelauxetic series were deduced. (auth)

44012 EXPERIMENTAL CONTRIBUTION TO THE MEASUREMENT OF OPTICAL SPECTRA BY SCATTERED TRANSMISSION. Schmieder, H.; Dornberger, E.; Kanellakopulos, B. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Appl. Spectrosc.; 24: 499-505(Sep-Oct 1970).

Teflon powder, compressed with the sample, is shown to have excellent properties for the measurement of spectra of polycrystalline actinide and lanthanide compounds by scattered transmission in the region from 350 to 2600 nm. In this way spectra can be obtained using samples which are extremely air and moisture sensitive. For example, the spectrum of pyrophoric tris-(cyclopentadienyl) uranium(III) was measured. The resolution, especially in the ir region, is better than obtained by reflection methods, as is shown using ferrocene samples. (auth)

44013 PHOTOCHEMICAL REACTIONS OF URANYL IONS WITH ORGANIC COMPOUNDS. I. THE MECHANISM OF THE URANYL ION-PHOTOSENSITIZED OXIDATION OF LACTIC ACID. Sakuraba, Shukichi; Matsushima, Ryoka (Shizuoka Univ., Hamamatsu, Japan). Bull. Chem. Soc. Jap.; 43: 1950-5(Jul 1970).

The photochemical reaction of lactic acid with uranyl ions in an aqueous solution was studied with radiations of 4050 and 4360 Å. The quantum yields and molar ratios of the reaction products were measured under various conditions. Two competing photoreactions appeared to take place; through them lactic acid was oxidized to form pyruvic acid at a lower pH and to form acetaldehyde, with an evolution of carbon dioxide, at a higher pH. The results obtained can be well explained by assuming that the excitation of the uranyl lactate complex is involved in the formation of acetaldehyde and that a collision between lactic acid and the excited uranyl ion, without any complex formation, is involved in the formation of pyruvic acid. (auth)

44014 SECONDARY DEUTERIUM ISOTOPE EFFECTS IN RADICAL-FORMING REACTIONS. V. t-BUTYL PERACETATE AND SUBSTITUTED t-BUTYL PHENYLPERACETATES. Koenig, T.; Huntington, J.; Cruthoff, R. (Univ. of Oregon, Eugene). J. Amer. Chem. Soc.; 92: 5413-18(9 Sep 1970).

The secondary deuterium isotope effects on the thermal decomposition of tert-butyl peracetate (A), tert-butyl p-nitrophenylperacetate (B), the tert-butyl p-methoxyphenylperacetate (C), were measured. The isotope effect for compound A is very small (k_H/k_D= 1.00 ± 0.02 in isooctane at 130.10°). The isotope effect on the decomposition of B is 1.10 for two deuteriums at 85° in chlorobenzene and 1.09 at the same temperature in Nujol. Compound C has an isotope effect of 1.07 for two deuteriums in isooctane at 60.4°, and at the same temperature in Nujol the effect is found to be 1.05. The very small isotope effect for A is interpreted in terms of a nonconcerted decomposition, while the larger effects observed for B and C are compared to that observed in the case of tert-butyl phenylperacetate. A study of oxygen-18 scrambling in the decomposition of A is discussed in terms of possible mechanistic refinements for perester decompositions. (auth)

44015 SOLVOLYSIS OF ARYL-SUBSTITUTED VINYL SULFONATES BY A HETEROLYTIC MECHANISM. Jones, W. M.; Maness, D. D. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc.; 92: 5457-64(9 Sep 1970).

A number of triphenylvinyl sulfonates were synthesized by the reaction of the acyltriazene 2 with sulfonic acids. 1-Phenylvinyl fluorosulfonate was synthesized by the addition of fluorosulfuric acid to phenylacetylene. The solvolyses of these sulfonic acid esters were studied. Both product and kinetic evidence point to a simple SN1 ionization mechanism. The following were eliminated as possible reaction mechanisms: SN2 nucleophilic substitution by acetate ion; acetate addition–elimination; slow proton addition to the double bond with subsequent elimination (and rearrangement); and nucleophilic attack on the sulfur of the sulfonate moiety. An m value of 0.56 was determined for the triphenylvinyl triflate by a Grunwald–Winstein relationship. The effect of solvent nucleophilicity on the ionization was shown to be small. The β-deuterium isotope effect was found to be k_H/k_D= 1.45 ± 0.04. This value agrees quite well with secondary isotope effects for saturated systems involving cationic intermediates. The effect of β-phenyl substitution appears to be small, probably as a result of compensating effects. The resistance of substituted ethylenes to undergo Sn1 solvolyses is discussed. (auth)

44016 THIOACETAL HYDROLYSIS. HYDROLYSIS OF BENZALDEHYDE METHYL S-(SUBSTITUTED PHENYL) THIOACETALS. Fife, Thomas H.; Anderson, Edwin (Univ. of Southern California, Los Angeles). J. Amer. Chem. Soc.; 92: 5464-8(9 Sep 1970).

The rate constants for acid-catalyzed hydrolysis of a series of benzaldehyde methyl S-(substituted phenyl) thioacetals were measured at 30° in 20% dioxane–H_2O. General acid catalysis could not be detected with any of these compounds. The value of ΔS^* for the hydronium ion catalyzed hydrolysis of the unsubstituted derivative was –4.8 eu. This reaction was much faster in D_2O than H_2O, the ratio k_D/k_H being 1.51. The ρ value for acid-catalyzed hydrolysis of the series was –1.0. An A1 mechanism was indicated with the carbon–sulfur bond breaking in the rate-determining step. The hydrolysis of the 2,4-dinitrophenyl derivative was pH independent from pH 1.5 to 0.1M NaOH. This reaction proceeded at approximately the same rate in D_2O as in H_2O (k_{D_2O}/k_{H_2O} = 0.90). The pH-independent reaction is therefore very likely a unimolecular decomposition to 2,4-dinitrothiophenoxide ion and a resonance-stabilized carbonium ion. (auth)

44017 CROSSLINKING COTTON CELLULOSE WITH ETHYLENEUREA DERIVATIVES HAVING VARYING HYDROGEN-BONDING CAPABILITIES. II. ACCESSIBILITY DETERMINATIONS. Stevens, C. V.; Smith, B. F. (Cornell Univ., Ithaca, N. Y.). J. Appl. Polym. Sci.; 14: 1691-1700(Jul 1970).

In a continuation of previously reported work on the effects on cotton cellulose of ethyleneurea crosslinking agents modified with ring substituents of varying hydrogen-bonding capabilities, accessibilities of the cellulosic hydroxylic protons to exchange with deuterium oxide vapor were determined by means of infrared spectroscopy. In analyzing these values with respect to previously reported data on physical properties of the treated fabrics, it was found that accessibility to deuterium oxide did not correlate with moisture regain of the resin-treated samples as was reported for physically modified celluloses. It appears that the different resins did have some effect on the structure of water adsorbed by the fiber and also that the solvent affected the manner in which the resins attached themselves to the cellulose and eliminated water from the structure. Values of accessibility were not found to correlate well with crease recovery, although a weak trend was indicated. Accessibility was found to decrease as the infrared band for ring stretching decreased. (auth)

44018 POLAROGRAPHY OF URANYL-DIETHYLENETRIAMINEPENTAACETATE COMPLEXES AND ADSORPTION KINETICS AT THE DROPPING MERCURY ELECTRODE. Lai, Tsai-teh; Wen, Chaur-shyong (Cheng Kung Univ., Tainan, Taiwan). J. Electrochem. Soc.; 117: 1122-6(Sep 1970).

The chelation of uranium(VI) with diethylenetriaminepentaacetate, DTPA, indexed as [(carboxymethylimino)bis(ethylenenitrilo)] tetraacetate, was investigated polarographically over the pH range 3.7 to 8.4 and ligand concentration range 0.005 to 0.1M. The predominant chelate species was found to be $UO_2(OH)H_2A^{2-}$ with the logarithmic formation constant of 2.96 at pH 6.4 to 7.5 and ionic strength 0.25. In the presence of Triton X-100 <0.003%, a single irreversible and diffusion-controlled wave was obtained. The kinetic parameters were determined (k_s is the order of 10^{-3} cm/sec and α = 0.42 ± 0.02). When the concentration of Triton X-100 was greater than 0.003%, the single wave split into two irreversible waves, due to the adsorption of surface-active substances. (auth)

44019 MEASUREMENT OF THE ADSORPTION HEATS AND ENTROPIES OF CH_4 AND CD_4 ON GRAPHITIZED CARBON BLACK BY ELUTION CHROMATOGRAPHY. Pareja, Pierre; Amariglio, Henri (Centre de Premier Cycle, Nancy). J. Chim. Phys.; 67: 938-42(May 1970). (In French).

Heats and standard entropies were chromatographically determined for the adsorption of CH_4 and CD_4 on two graphitized carbon black samples, from 112.4 to 199°K. Any inversion of the elution order could not be observed, contrasting with the case of chromatography through a silica column. The ratio of the volumes retained varied linearly with the reciprocal of the absolute temperature. The performances of thick layer capillary columns were compared with packed columns. (auth) (France)

44020 ON THE PRECISE MEASUREMENT OF THE ISOTOPIC SHIFT OF THE 1.5295-μ MERCURY LINE BY THE OPTICAL AND UHF METHODS. Beterov, I. M.; Klementev, V. M.; Chebotaev, V. P. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 208-9(Sep 1969).

Translated from Opt. Spektrosk.; 27: 388-90(Sep 1969).

During laser action in the middle of the isotope lines of a Hg vapor laser, measurements were made by variation of the resonator length of the isotopic shift between the components of the 1.5295 μ line for the ^{200}Hg and ^{202}Hg isotopes; the shift proved to equal $\Delta\nu$ = 4327 ± 5 MHz. The possibilities of using a mercury laser to solve a number of problems are discussed. (auth)

44021 STUDY OF MELTING IN SALT SYSTEMS CONTAINING URANIUM TRICHLORIDE. Desyatnik, V. N.; Mel'nikov, Yu. T.; Nichkov, I. F.; Raspopin, S. P.; Makosov, V. V. At. Energ. (USSR); 28: 247-9(Mar 1970). (In Russian).

Salt systems containing UCl_3 can reduce other compounds to metals. Thus lead chloride can be reduced to the metal as follows: $PbCl_2 + 2\ UCl_3 \rightarrow 2\ UCl_4 + Pb$. Differential thermal analysis of this system with subsequent determination of lead metal confirmed the above reaction. The most complete reaction takes place after holding 5 to 6 hrs at a temperature of 550 to 650°C with equimolecular amounts of $PbCl_2$ and UCl_3. After formation of UCl_4 the $PbCl_2$–UCl_3 system is converted to the ternary $PbCl_2$–UCl_3–UCl_4 system. The region of a solid solution of uranium tetrachloride in UCl_3 was determined along with the compound 4 $PbCl_2 \cdot UCl_3$ which melts congruently at 512°C, and two eutectics containing 11 and 25% UCl_3 with melting points of 473 and 478°C respectively. A temperature arrest at 327°C corresponding to the melting point of lead metal was observed on the thermograms. Phase diagrams are presented at various temperatures to show these relationships for this system. (TTT)

44022 CATALYTIC EFFECT OF IRON ON OXIDATION OF PLUTONIUM BY HYDROGEN PEROXIDE. Sill, Claude W.; Percival, Donald R.; Williams, Rodger L. (Health Services Lab., Idaho Falls, Idaho). Anal. Chem.; 42: 1273-5(Sep 1970).

It was found that in many cases the addition of hydrogen peroxide for the separation of uranium from the transuranium elements after a barium sulfate precipitation affects the quantity of unprecipitated plutonium. It was demonstrated that iron, if present in sufficient amounts, acts as a catalyst on the oxidation of Pu by hydrogen peroxide, and is therefore responsible for the phenomenon. (J.G.B.)

44023 POLAROGRAPHY OF URANIUM(VI) –ARSONOACETATE COMPLEX. Lai, Tsai-teh; Chou, Tse-chuan (Cheng Kung Univ., Tainan, Taiwan). J. Chin. Chem. Soc. (Taiwan); 17: 72-80(Jun 1970).

The complexation of uranium(VI) with arsonacetic acid has been studied polarographically. A two-step polarographic wave was obtained at lower pH value. The dissociation reaction of the complex was deduced from the kinetic current of the prewave. The asymmetry to half-wave of polarograms was interpreted on the basis of polynuclear complex. The limits of reversibility, chelation, polymerization, and precipitation of the complex, which are functions of pH and ligand concentration, were found. (auth)

44024 COMPLEXOGENIC PROPERTIES OF FLAVANONE DERIVATIVES. PART III. STUDIES ON HESPERETIN COMPLEX WITH UO_2^{++} IONS. Korkuc, Anna (Dept. of Inorganic and Analytical Chemistry, Lodz, Poland). Rocz. Chem.; 44: 997-1001(1970). (In Polish).

In an aqueous–methanol medium hesperetin with UO_2^{2+} ions forms two complex compounds. Binding ratios of components in the compounds were determined by the following methods: Job's, Bent and French's, Babko's. The binding ratios amount to: UO_2^{2+} : H – t = 1 : 1 at pH ≈ 2.1, and 1 : 2 at pH ca 5.3. These complexes are yellow or orange. The absorption maximum lies within the range λ = 375–410 nm. Molar absorption coefficients amount to: $\epsilon_{(\lambda=390nm,pH=2.1)} = 210$, $\epsilon_{(\lambda=390um,pH=7.02)} = 3680$. (auth)

44025 ISOTOPIC EXCHANGE OF OXYGEN IN PROCESS OF ROCK FORMATION. Dontsova, E. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 8, 903-16(Aug 1970). (In Russian).

Isotopic exchange between rocks and volatiles or solutions is considered with oxygen as an example. Some general regularities of the isotopic exchange are established. It is possible to estimate a priori the ability of minerals for oxygen isotope exchange. Data on isotopic ratios of oxygen in magmatic, metamorphic, and hydrothermal solutions were selected. The revealed exchange regularities were used for geochemical examination of data on the isotopic ratios of oxygen in the lithosphere. An estimation of the influence of solutions upon the formation of the oxygen isotope composition of igneous and metamorphic rocks was made. The scale of isotopic exchange of oxygen between rocks and solutions in metamorphic and hydrothermal processes was estimated. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 43934, 43985, 44056, 44078, 44422–44424, 44431, 44440, 44640, 44967, and 45994.

44026 (BNL–50205, pp 35-49) CHEMISTRY DIVISION. Wiswall, R. H. Jr. (Brookhaven National Lab., Upton, N. Y.).

Topics covered include: fluorocarbon chemistry, porphyrins, radiation effects on halogenated compounds, molecular spectra and structure, metal hydrides, magnetic susceptibility, temperature sensor, spectra of molten salts, solutions of gases in molten salts, use of F centers in alloy thermodynamic measurements, and thermodynamic properties of Ag I. (M.C.G.)

44027 (BNL–50205, pp 50-77) RADIATION DIVISION. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.).

Topics covered include: solid-state reactions, colloids and surface phenomena, vinyl polymerization mechanisms, radiolysis in the adsorbed state, fission fragment and radiation chemistry, radiation chemical processing, ethylene and ethylene copolymers, survey experiments on application of isotopic radiation for chemical work, radiation chemical reactor studies, laboratory operations for high-intensity radiation development, gamma facility, source development, dose distribution, dosimetry and dosimeter development, food program, atmospheric diagnostics program, ball lightening, and MHD power cycles. (M.C.G.)

44028 (EUR–4452, pp 715-36) MICRODOSIMETRIC CONCLUSIONS FROM CONDUCTIVITY MEASUREMENTS IN GAMMA-IRRADIATED DIELECTRIC LIQUIDS. Jacobi, W.; Hacke, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). (In German).

The variation of conductivity in γ-irradiated dielectric liquids is accounted for by the theory developed by Onsager concerning preferential ion recombination in compressed gases. With reference to hexane it is shown that from the dependence of conductivity on field strength and temperature, quantitative information on the ion yield, the mean energy consumption, W, per ion pair, the probability of initial recombination and the spatial distribution of the ions in the zone of the path of ionizing particles of low-energy LET can be obtained. The results with various liquids are summarized and discussed and the validity of the theory is demonstrated. (auth) (EURATOM)

44029 (PRNC–139) HOT ATOM CHEMISTRY PROGRAM. Progress Summary Report No. 5, April 1969–April 1970. Wheeler, Owen H.; Trabal, J. E.; McClin, M. L.; Lopez Alonso, H.; Vallejos, A.; Pena, N. (Puerto Rico Nuclear Center, Mayaguez). 7p. Dep. CFSTI.

Progress is reported on a study of the mechanisms of Szilard–Chalmers processes in organic compounds containing direct multiple bonds between the heavy activated atom and carbon atoms of the organic radical. (D.H.M.)

44030 PRODUCTION OF CARRIER-FREE ^{47}Ca. Vil'gel'mova, L.; Nikityuk, L. N.; Rybakov, V. N. Radiokhimiya; 12: 407-9(1969). (In Russian).

A method was developed for the production and isolation of carrier-free ^{47}Ca from a complex mixture of products from high-energy proton reactions with vanadium. The radiochemical purity of the isolated fraction was examined. (tr-auth)

44031 RELATIVE YIELD OF Xe ISOTOPES ON IRRADIATION OF Ba BY PROTONS WITH AN ENERGY OF 680 MeV. Levskii, L. K.; Murin, A. N.; Yutalandov, I. A. Radiokhimiya; 12: 409-10(1969). (In Russian).

The isotopic composition of xenon from a barium target on irradiation of the latter by 680-MeV protons was studied. The results of measurements on two targets are given. (tr-auth)

44032 PULSE RADIOLYTIC INDUCED TRANSIENT ELECTRICAL CONDUCTANCE IN LIQUID SOLUTIONS. PART 3. RADIOLYSIS OF AQUEOUS SOLUTIONS OF SOME INORGANIC SYSTEMS. Barker, G. C.; Fowles, P. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc.; 66: 1661-9 (Jul 1970).

A conductance technique was used to study the radiolysis of aqueous solutions of some inorganic cations and of O_2 within the first millisecond after exposure to a submicrosecond pulse of 15-MeV electrons. Further evidence was obtained for the reduction of Cd^{2+} and Ni^{2+} to unstable monovalent species. The conductance changes produced in solutions of Ag^+ and Cu^{2+} were explicable only if OH radical oxidation was included in addition to reduction. The rate constants for OH + Ag^+ and OH + Cu^{2+} were 6.3×10^9 and 3×10^8 l mole^{-1} s^{-1}, respectively. The technique can be used to determine a value of pK (HO_2) = 4.80. The ratios of $g(H^+)$ to $g(e^-)$, g(OH), and g(H), respectively were in agreement with expected values. (auth) (UK)

44033 CHEMISTRY OF RECOIL TRITIUM ATOMS. PART 2. RELATIVE ENERGIES OF HOT ATOM REACTIONS. Urch, D. S.; Welch, M. J.; Arthy, R. J. (Queen Mary Coll., London). Trans. Faraday Soc.; 66: 1642-7(Jul 1970).

The kinetic theory of Estrup and Wolfgang was extended to estimate the relative energy range of recoil tritium hot-atom reactions. Maximum and minimum values of K the energy shadowing integral can be calculated and a parameter R is introduced which indicates, as it varies from 0 to 1 whether the product is formed by high or low energy "hot" atoms. Whilst results from oxygen and bromine scavenged (or helium and non-helium moderated) systems do not agree as to which is the "high energy" product, (HT or labelled parent hydrocarbon) each hot product is produced by recoil atoms with different amounts of excess energy. (auth) (UK)

44034 RAPID METHOD FOR ISOLATION OF RARE EARTH AND TRANSPLUTONIUM ELEMENTS FROM URANIUM TARGETS IRRADIATED BY HEAVY IONS. Kush, V.; Mikul'ski, Ya.; Shcheglovski, Z. Radiokhimiya; 12: 401-5(1969).

A rapid method was developed for the isolation of rare earth and transplutonium elements from uranium targets irradiated with ^{12}C ions. The method permits thin sources for alpha spectroscopy to be prepared from transplutonium elements. (tr-auth)

44035 NOVEL MEMBRANES PREPARED BY RADIATION GRAFTING OF STYRENE TO CELLULOSE ACETATE. Hopfenberg, H. B.; Stannett, V.; Kimura, F.; Rigney, P. T. (North Carolina State Univ., Raleigh). Appl. Polym. Symp.; No. 13, 139-55(1970).

From Symposium on Membranes from Cellulose and Cellulose Derivatives, Minneapolis, Minn. See CONF-690444.

The effects of styrene grafting on the reverse osmosis properties of asymmetric cellulose acetate membranes, which have been modified by grafting with polystyrene, were studied. One of the major limitations of cellulose acetate reverse osmosis membranes is the reduction of product flux and/or rejection with time. This time dependent process, resulting from compressive compaction, can be reduced by controlled radioinduced graft copolymerization of polystyrene to the cellulose acetate backbone. Styrene has been successfully grafted to dense homogeneous cellulose acetate film as well as to highly asymmetric Loeb-type membranes. Alternatively, dense and asymmetric membranes have been cast from highly purified styrene grafted cellulose acetate freed of residual homopolymer. A variety of mutual grafting techniques have been evaluated. The effects of γ-radiation dose, swelling agent type and concentration, extraction and purification procedure, and various solvent exchange techniques on the flux-rejection characteristics of the membranes have been determined. The most attractive method for the preparation of grafted asymmetric membranes appears to be radiation of a styrene-containing ternary casting solution followed by casting according to a modified Loeb–Manjikian technique. (auth)

44036 SELECTIVITY IN THE REACTIONS OF e^-_{aq} AND OH RADICALS WITH SIMPLE PEPTIDES IN AQUEOUS SOLUTION. OPTICAL ABSORPTION SPECTRA OF INTERMEDIATES. Simic, M.; Neta, P.; Hayon, E. (Army Natick Labs., Mass.). J. Amer. Chem. Soc.; 92: 4763-8(12 Aug 1970).

The reactivity and site of attack of OH radicals with the simple peptides acetylglycine, acetylglycylglycine, diglycine, and triglycine in aqueous solutions were studied using the technique of pulse radiolysis. The reaction rate constants k(OH + P) were found to be markedly dependent upon pH in the range 4 to 10 for Gly-Gly and Gly-Gly-Gly, but independent of pH for Ac-Gly and Ac-Gly-Gly. This dependence of k(OH + P) on pH was shown to correspond to the state of protonation of the terminal amino group. These results were used in the interpretation of the optical absorption spectra of the intermediates produced, e.g., $OH + {}^+NH_3CH_2CONHCH_2COO^- \rightarrow {}^+NH_3CH_2CONH\dot{C}HCOO^- + H_2O$; $OH + NH_2CH_2CONHCH_2COO^- \rightarrow NH_2\dot{C}HCONHCH_2COO^- + H_2O$; $OH + CH_3CONHCH_2COO^- \rightarrow CH_3CONH\dot{C}HCOO^- + H_2O$. The acid-base properties of the radicals were followed and pK values derived. The radicals $Ac-NH\dot{C}HCOO^-$ and $Ac-Gly-NH\dot{C}NCOO^-$ have absorption maxima in the region 250 to 270 nm and extinction coefficients $\epsilon \sim 14{,}000\ M^{-1}\ cm^{-1}$; the radicals ${}^+H_2-Gly-NH\dot{C}HCOO^-$ and $NH_2\dot{C}HCO-Gly-O^-$ (and their triglycine equivalents) have maxima at ~260 nm and ϵ values of ~12,000 and ~5000 $M^{-1}\ cm^{-1}$, respectively. At biological pH values, products from attack at both positions can be expected for the decomposition of these simple peptides. High selectivity for the reaction e^-_{aq} with Gly-Gly and Gly-Ala were observed, leading to almost quantitative (~80%) reductive deamination: $e^-_{aq} + {}^+NH_3CH_2CONHCHRCOO^- \rightarrow NH_3 + \cdot CH_2CONHCHRCOO^-$. The $\cdot CH_2CONHCHRCOO^-$ radicals have maxima at ~435 nm and extinction coefficients of ~1200 $M^{-1}\ cm^{-1}$. (auth)

44037 RADICAL–OXYGEN AND RADICAL–RADICAL REACTION RATES DURING DISSOLUTION OF IRRADIATED SOLID COMPOUNDS IN WATER. Loefroth, G.; Kim, Ch. (Univ. of Stockholm). Radiat. Eff.; 3: 217-20(Jun 1970).

By measuring the oxygen consumption during dissolution of irradiated solid compounds in water with different oxygen concentrations, the ratio of the radical–oxygen and radical–radical reaction rates can be obtained. In a series of six compounds with molecular weights from 75 to 504, the ratio of the reaction rates increased from 2 to 3 to over 20. The increasing dominance of the radical–oxygen reaction rate over the radical–radical one at increasing molecular size probably depends on a combination of diffusion and steric factors. The radical concentration of the irradiated solid compound can be evaluated by a linear extrapolation of the oxygen consumption to infinite oxygen concentration in the dissolution water. The radioinduced radical yields, measured in this manner, agree well with results obtained by ESR investigations. (auth)

44038 CARBONIUM IONS IN RADIATION CHEMISTRY. REACTIONS OF t-BUTYL IONS WITH HYDROCARBONS. Ausloos, P.; Lias, S. G. (National Bureau of Standards, Washington, D. C.). J. Amer. Chem. Soc.; 92: 5037-45(26 Aug 1970).

t-Butyl ions, generated by the γ irradiation of neopentane, undergo hydride transfer reactions with alkanes having tertiary hydrogen atoms ($t\text{-}C_4H_9^+ + RH \rightarrow i\text{-}C_4H_{10} + R^+$) to form isobutane and a tertiary carbonium ion as products. By irradiating neopentane in the presence of mixtures of two reactant molecules, one deuterated and one nondeuterated, the relative rates of the hydride transfer reaction for 22 C_5 to C_8 alkanes were determined with an unusually high accuracy, from the observed ratios of $i\text{-}C_4H_9D$ to $i\text{-}C_4H_{10}$. Absolute rate constants for the reactions, based on a determination of the rate of depletion of the isobutane yield when ammonia is added, are given. The rate constants are generally very low [10^{-11} to 10^{-10} cm^3/(molecule sec)], but were found to depend on the heat of reaction and steric factors involving van der Waals interactions between the approaching ion and hydrogen atoms or methyl groups on the carbon atom β to the tertiary carbon. The evidence indicates that the hydride transfer reactions of the t-butyl ion have an activation energy, $E_{act} \leq 0.15$ eV. In another series of experiments, unsaturated hydrocarbons were added to neopentane–isopentane mixtures, and the rates of the condensation reaction of these additives with t-butyl ions were determined by measuring the rate of depletion of the isobutane yield. The rate constants for the condensation reactions are in the range 10^{-10} to 10^{-9} cm^3/(molecule sec). Some insight into processes occurring in the radiolysis of neopentane can be gained from these results. It was found, for example, that in the absence of reactive additives, not more than about 14% of the t-butyl ions undergoes processes resulting in the formation of isobutane. (auth)

44039 ABSORPTION SPECTROSCOPY OF IRRADIATED POLY(VINYL)CHLORIDE. Salovey, R.; Albarino, R. V.; Luongo, J. P. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Macromolecules; 3: 314-18(May-Jun 1970).

The radiolysis of poly(vinyl chloride) (PVC) was studied by ultraviolet and visible spectroscopy following post-irradiation storage at selected temperatures in a cryostatic cell. A sequence of alkyl, allyl, and polyenyl radicals followed by chain transfer to PVC led to polyene formation. Allyl, dienyl, and trienyl radicals were associated with absorption bands at 2520, 2910, and 3300 Å, respectively. Radical intermediates reacted readily with oxygen. (auth)

44040 ^{60}Co γ-RAY RADIOLYSIS OF SULPHONATED CATION RESIN ZEOCARB-225. Rahman, M. K. (Atomic Energy Centre, Dacca, Pakistan); Clay, P. G. Nucleus (Karachi); 6: 221-8(Oct-Dec 1969).

The radiation damage of sulfonated cation exchange resin (Zeocarb-225) under different conditions has been studied using gamma radiation from a ^{60}Co source. The roles played by varying the water content of the resin and different scavenger solutions were investigated. The experimental observations revealed that the damage proceeds through both direct and indirect radiation effects and evidence was obtained to show that the species responsible for indirect attack is probably the OH radical. (auth)

44041 HOT-ATOM CHEMISTRY OF TRIS-(ACETYLACETONATO)-COBALT(III) IN BENZENE SOLUTIONS AND FROZEN BENZENE SOLUTIONS. Tominaga, Takeshi; Fujiwara, Kiato (Tokyo Univ.). Bull. Chem. Soc. Jap.; 43: 2279(Jul 1970).

Data are reported on the ^{60}Co recoil reaction in benzene solution and frozen benzene solutions of tris(acetylacetonate)cobalt(III) and the scavenger effect of ferric chloride added to the system for the purpose of removing free acetylacetone. (D.H.M.)

44042 OBSERVATION OF COORDINATED FREE RADICALS FORMED IN THE REACTION OF HYDROXYL RADICALS WITH BENZOATOPENTAAMMINECOBALT(III) IN AQUEOUS SOLUTION. Hoffman, Morton Z.; Simic, M. (Army Natick Labs., Mass.). J. Amer. Chem. Soc.; 92: 5533-4(9 Sep 1970).

The observation of a coordinated free radical transient formed in the reaction of OH radicals with $(NH_3)_5Co(O_2CPh)^{2+}$ using pulse radiolysis methods is reported. Results indicated that the OH radical adds to the benzoato ligand to form $(NH_3)_5Co(III)(O_2CC_6H_5OH)^{2+}$ The absorption spectrum of this transient species, resulting from transitions localized on the benzoato OH radical, is intermediate between those for the protonated and anionic forms of the OH adduct to free benzoate in keeping with the intermediate nature of the carboxylate group coordinated to the metal center. (J.G.B.)

44043 REACTION OF RECOIL TRITIUM ATOMS IN A MIXTURE OF CARBON TETRACHLORIDE AND ALIPHATIC ACIDS. Okamoto, Jiro; Tuazon, Lourdes Ocampo; Danno, Akibumi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 366-70(Jul 1970).

Yields of products from neutron irradiation of a mixture of carbon tetrachloride as additive and aliphatic acids containing lithium chloride were investigated. In each system, the major products were HT, T-labeled aliphatic acid, and T-labeled hydrocarbons. The yield resulting from the abstraction reaction of hydrogen atoms bonded to carbon atoms was affected by the concentration of the additive and depended on the C—H bond

strength. The substitution reaction of recoil tritium was not influenced by the concentration of additive. The yield of degradated products from the mixture was smaller than from the irradiation of pure acid. This may be interpreted to be the result of dimer formation in a non-polar solvent. (auth)

44044 DEGRADATION OF POLY(VINYL CHLORIDE). I. KINETICS OF THERMAL AND RADIATION-INDUCED DEHYDROCHLORINATION REACTIONS AT LOW TEMPERATURES. Palma, G.; Carenza, M. (CNR, Bologna). J. Appl. Polym. Sci.; 14: 1737-54(Jul 1970).

The dehydrochlorination reaction arising thermally and from exposure to γ radiation was followed, under vacuum, in the temperature range from 80 to 130°C by measuring the pressure of the evolved volatiles. The catalytic action of HCl, which was recently established, was observed also at these low temperatures. In agreement with previous data, a free-radical mechanism was accepted to be operating in the radioinduced reaction, which was found to be linearly dependent on dose rate and essentially independent of temperature. Assuming the thermal dehydrochlorination to proceed according to the same mechanism, its activation energy, lying within the range of values reported in the literature, represents the activation energy for the thermal process of radical formation by dissociation of normal and anomalous structures in PVC macromolecular chains. Since this value appears to be substantially constant in the temperature range from 90 to 240°C, it can be established whether the dissociation reactions of all the PVC structures are regulated by the same activation energy or, more simply, only one of these structures is concerned. (auth)

44045 RADIATION-INITIATED SOLUTION POLYMERIZATION OF VINYLIDENE FLUORIDE. Doll, W. W.; Lando, J. B. (Case Western Reserve Univ., Cleveland). J. Appl. Polym. Sci.; 14: 1767-73(Jul 1970).

The radiation-initiated solution polymerization of vinylidene fluoride was examined in an effort to determine the effects of polymerization conditions on the head-to-head content of the resulting poly(vinylidene fluoride). No appreciable change was observed in the head-to-head content when this new type of polymerization was utilized. However, the polymers which resulted had melting points 10 to 15°C higher than those of the suspension-polymerized poly(vinylidene fluoride), higher crystallinity, and, when trifluoroacetic acid was used as a solvent, a higher molecular weight. (auth)

44046 RADIATION-CONVERTIBLE POLYMERS FROM NORBORNENYL DERIVATIVES. CROSSLINKING WITH IONIZING RADIATION. Colomb, H. O. Jr. (Union Carbide Corp., South Charleston, W. Va.); Trecker, D. J.; Osterholtz, F. D. J. Appl. Polym. Sci.; 14: 1659-70(Jul 1970).

Vinyl polymers with pendant norbornenyl (bicyclo[2.2.1]heptenyl) groups crosslinked rapidly on exposure to ionizing radiation. Analysis (according to Charlesby–Pinner theory) of extraction data from an ethylene–vinyl acetate copolymer and the corresponding ethylene–vinyl norbornenecarboxylate copolymer showed that the unsaturated polymer crosslinked by a chain reaction. At low doses, the kinetic chain length was about 4. Pendant norbornenyl groups accelerated crosslinking of a vinyl alcohol–vinyl acetate–vinyl chloride copolymer and converted poly(vinyl alcohols) and cellulose acetate from degrading to crosslinking polymers. A novel application of the Charlesby–Pinner plot strongly suggests linear dependence of the extent of crosslinking on the norbornenyl group concentration in a series of modified poly(vinyl alcohols). The greater effectiveness of pendant norbornenyl groups, compared to cyclohexenyl groups, demonstrated the importance of the reactivity of the double bond. (auth)

44047 HYDROGEN FORMATION IN THE RADIOLYSIS OF SATURATED HYDROCARBONS IN THE LIQUID AND SOLID PHASES. EFFECT OF TEMPERATURE. Kimura, Toyoaki; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 43: 1657-61(Jun 1970).

Hydrogen yields were determined for thirteen saturated hydrocarbons (n-pentane, cyclopentane, methylcyclopentane, 3-methylpentane, n-hexane, cyclohexane, methylcyclohexane, n-heptane, n-octane, 2,2,4-trimethylpentane, n-nonane, n-decane, and polyethylene) γ irradiated at 20°C, −72°C, and −196°C. The decrease in hydrogen yield with decreasing temperature from 20°C to −196°C was correlated with the yield of thermal hydrogen atoms, which was obtained by adding ethylene as a scavenger at 20°C; the decrease in most cases was nearly equal to a half of the thermal hydrogen atom yield. Evidence of thermal hydrogen atom production at −196°C was also demonstrated by ESR measurement. It was concluded that thermal hydrogen atoms abstract hydrogen atoms from solvent molecules at 20°C, but they mostly recombine with each other to form hydrogen molecules at −196°C. An empirical formula based on the C−H bond parameter has been presented which is adapted for the hydrogen yield from normal alkanes. (auth)

44048 REACTION INTERMEDIATES IN γ-IRRADIATED MERCAPTANS AT 77°K. Torikai, Ayako; Sawada, Shuzo; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 43: 1617-21(Jun 1970).

Elementary processes in the radiolysis of ethyl mercaptan were investigated by both spectrophotometric and electron spin resonance (ESR) methods. Ethyl mercaptan (C_2H_5SH) forms a glassy solid at 77°K, and when irradiated with γ-rays from ^{60}Co, it develops a deep orange color; this color fades upon illumination with visible light, leaving a clear yellow color. The ESR spectrum of γ-irradiated C_2H_5SH at 77°K consists of two components; one is a complex spectrum which was identified with the spectrum of $C_2H_5S\cdot$, while the other is a photobleachable broad singlet which was assigned to the ionic species. The $C_2H_5S\cdot$ radical shows an absorption spectrum with λ_{max} = 405 nm. The G-values for the formation of the radicals and the ionic species were 0.5 and 2.9, respectively. Studies of 2-methyltetrahydrofuran and butyl chloride solutions of C_2H_5SH were performed to identify these ionic species. Some significant elementary processes will be discussed on the basis of these results. (auth)

44049 GAS-PHASE RADIOLYSIS OF TOLUENE. Yamamoto, Yukio; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). J. Phys. Chem.; 74: 3325-32(3 Sep 1970).

The γ radiolysis of toluene in the gas phase was studied at room temperature as a function of pressure (1.5 to 18 mm) and added NO and N_2O. The G values obtained at 10.7 mm and a total dose of 1.9×10^{19} eV were hydrogen, 0.36; methane, 0.15; ethane, 0.07; acetylene, 0.41; benzene, 0.18; ethylbenzene, 0.05; xylenes, 0.05; 2-methyldiphenylmethane (MDPM), 0.05; 3-MDPM, 0.34; 4-MDPM, 0.05; and bibenzyl, 0.03. The effects of added NO indicated that ethane, ethylbenzene, xylenes, bibenzyl, and some of the benzene are formed by radical reactions but not acetylene and MDPMs. The product formation was compared with that of the γ radiolysis in the liquid phase and the mercury-sensitized photolysis in the gas phase which was reinvestigated in this study. The basic difference between these studies was due to the different reactive species formed by the β-bond fissions; in the gas-phase radiolysis $C_7H_7^+$ ions were formed and produced three isomers of MDPM, while in the photolysis and liquid phase radiolysis benzyl radicals, producing predominantly bibenzyl, were formed. The addition of N_2O resulted in a considerable increase of MDPMs and bibenzyl yields, which can be attributed to the additional formation of benzyl and tolyl radicals. (auth)

44050 RADIATION-INDUCED REACTION OF ISOBUTENE IN THE GAS PHASE. EFFECTS OF PRESSURE, TEMPERATURE, AND ADDITIVES ON POLYMERIZATION. Noro, Yasuyuki; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 43: 1894-6(Jun 1970).

Results of a study of the radioinduced polymerization of isobutene in the gas phase showed that the polymerization rate is proportional to the square of the pressure below ~800 torr and tends to become proportional to the pressure above ~800 torr. The polymerization rate of isobutene irradiated to 0.3 MRad at 0°C and at 500 torr was 1.8 times as great as that at 20°C at the same pressure and dose. The effects of sulfur hexafluoride, methyl bromide, oxygen, and nitrogen dioxide were also studied. (D.H.M.)

44051 EFFECT OF CRYSTAL SIZE ON THE RADIOLYSIS OF SOLID SUCCINIC ACID. Miyazaki, Tetsuo; Okada, Shigehiro; Wakayama, Terunobu; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 43: 1907(Jun 1970).

The radiolysis of succinic acid in single crystal and powder form was studied at 77°K. The values for $G(CO + H_2)$ for the powder and single crystal were about 0.5 and 0.1, respectively, at a dose of 4.6×10^6 Rad. There was no difference in the yield of CO_2 between powder and the single crystal; in both cases it was about 1.9 G-unit. (D.H.M.)

44052 SCAVENGER EFFECTS ON ELECTRONS PRODUCED BY γ RAYS AND PHOTOIONIZATION IN ALKALINE ICES AT 77°K. Hase, Hirotomo; Kevan, Larry (Wayne State Univ., Detroit). J. Phys. Chem.; 74: 3358-61(3 Sep 1970).

Acrylamide was used as an electron scavenger in the radiolysis and ferrocyanide photoionization of 5 and 10 M NaOH ices. The concentration of acrylamide required to reduce the e_i^- yield to one-half its initial value was higher for γ radiolysis than for ferrocyanide photoionization by a factor of about 3.5. This difference was found to be due to the spatial nonuniformity of e_m^- generated by

γ rays. Within the framework of a simple model the average travel distance of e^-_m is 56 Å and 44 Å in 5 and 10 M NaOH ices, respectively, for both photoionization-produced and radiation-produced electrons. A kinetic analysis suggested that a high concentration of solute molecules tends to destroy trapping sites in the ices. (auth)

44053 TRAPPED HYDROGEN ATOMS PRODUCED BY γ RAYS IN ALCOHOL–WATER MIXTURES AT 77°K. Hase, Hirotomo; Kevan, Larry (Wayne State Univ., Detroit). J. Phys. Chem.; 74: 3355-8(3 Sep 1970).

Small H_t yields ($G_{max} \sim 0.1$) were observed in γ-irradiated MeOH–H_2O, EtOH–H_2O, and n-PrOH–H_2O mixtures at 77°K although H_t was not observed in either pure component at 77°K. The H_t yield showed a maximum at 0.1 to 0.3 mole fraction alcohol; the maximum occurred at lower mole fraction for longer chain alcohols. Electrons were also trapped in the mixtures and when they were photobleached the H_t yield increased. The H_t yields showed a striking correlation with the excess enthalpy of mixing of alcohol–water mixtures; both effects seemed to be related to alcohol–water complex formation. EPR line widths in deuterated mixtures gave information on the trapping site structure, and the H_t yields in deuterated mixtures suggest that most of the H_t comes from the water molecules. (auth)

44054 REACTION OF NITRILES WITH HYDRATED ELECTRONS AND HYDROGEN ATOMS IN AQUEOUS SOLUTION AS STUDIED BY ELECTRON SPIN RESONANCE. Neta, P.; Fessenden, Richard W. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 74: 3362-5(3 Sep 1970).

The radicals produced by reaction of hydrated electrons and hydrogen atoms with nitriles in irradiated aqueous solutions were studied by ESR. Irradiation with high-energy electrons was carried out directly in the ESR cavity. Radicals of the type RCH=N· were observed; their ESR spectra were characterized by an 80-G proton doublet splitting and a 10-G nitrogen splitting. These radicals were formed from nitriles both by reaction with hydrated electrons followed by protonation and directly by reaction with hydrogen atoms. Only about 10% of the hydrated electrons formed CN^- as an additional product. No electron transfer from CO_2^- to nitriles was found to take place. Some of the radicals formed by OH reactions or by secondary reactions were also identified. (auth)

44055 RADIATION POLYMERIZATION OF ETHYLENE USING CARBON DIOXIDE AS REACTION MEDIUM. Kagiya, Tsutomu; Machi, Sueo; Kawakami, Waichiro; Hagiwara, Miyuki; Hosaki, Yoshihiko (to Japan Atomic Energy Research Inst.). U. S. Patent 3,516,912. 23 Jun 1970. Priority date 19 Apr 1966, Japan.

A process for the radioinduced preparation of polyethylene comprises passing a stream of a mixture of monomeric ethylene and CO_2 (<60 mole % of the ethylene) through a tubular reactor exposed to the radiation. The reaction temperature is 0 to 90°C. The reaction tube is exposed to an ionizing radiation dose of at least 10^4 R/hr for at least 1 hr. (B.L.M.)

Radiochemistry

44056 (BNL–50205, pp 78-92) HOT LABORATORY DIVISION. Stang, L. G. Jr. (Brookhaven National Lab., Upton, N. Y.).

Topics covered include: chemical effects of tellurium isomer decay, Szilard–Chalmers reactions, excitation function for triton-induced reactions in magnesium, recoil from the $^{48}Ca(\alpha,\alpha n)^{47}Ca$ reaction, fission resonance integrals in the transuranium region, ternary fission, nuclear level densities, evaporation calculations, mixed metal complexes, mixed ligand complexes, electrochemistry, air pollution, medical radionuclides, and hot laboratory operations. (M.C.G.)

44057 CHEMICAL EFFECTS ASSOCIATED WITH THE β-DECAY PROCESS. V. KINETIC STUDIES OF THE CHEMICAL BEHAVIOR OF THE ^{144}Pr FORMED BY THE DECAY OF THE ^{144}Ce(III)-ETHYLENEDIAMINETETRAACETATE AND ^{144}Ce(III)-TRANS-1,2-DIAMINOCYCLOHEXANE-N,N'-TETRAACETATE. Shiokawa, Takanobu; Kido, Hiroaki; Omori, Takashi (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 2076-9(Jul 1970).

The chemical effects associated with the β^--decay of ^{144}Ce(III)-aminopolycarboxylate complexes were further investigated. The chemical behavior of ^{144}Pr was analyzed kinetically on the basis of the isotopic exchange reaction mechanism. The formation of the intermediate complex produced by an intramolecular electron transfer of the ^{144}Pr(IV)-aminopolycarboxylate following the β^--decay of ^{144}Ce(III) complex was also confirmed. In the ethylenediaminetetraacetate and trans-1,2-diaminocyclohexane-N,N'-tetraacetate systems, the values for the bond-rupture of the daughter complex ions are much larger than in the diethylenetriaminepentaacetate system, suggesting that a kinetically-excited intermediate complex decomposes to a free ion to some extent. (auth)

44058 RADIOPOLAROGRAPHY OF THALLIUM. Culp, R. A.; Findeis, A. F. (Univ. of Alabama, University). Anal. Chem.; 42: 1285-7(Sep 1970).

Diffusion coefficients for thallium calculated from radiopolarographic data differ from those calculated from polarographic data. By calculating the number of atoms associated with the drops from both radiopolarographic and polarographic data, it was possible to measure a quantity apparently related to the residual charge on the drop. In an effort to convert rapidly the measured radioactivity to absolute activity, a new sample preparation technique was developed for measurement of β radiation using a cylindrical geometry foil flow counter. (J.G.B.)

44059 CHEMICALLY SIGNIFICANT DETAILS OF SOME NUCLEAR REACTIONS. Jones, C. H. W. (Simon Fraser Univ., Burnaby, B. C.). J. Phys. Chem.; 74: 3347-55(3 Sep 1970).

The chemical effects of nuclear transformations have been widely studied in solids. A study is presented which is to re-examine the sequence of events as they occur following thermal neutron capture in a solid. Experimental evidence recently reported in the literature is reviewed. In particular, attention is focused on the possible existence in the γ cascade following neutron capture, of delayed states with half-lives of nanoseconds or greater, and which may be highly internally converted. The stopping time for energetic atoms recoiling from nuclear reactions in solids is also discussed, and relevant experimental evidence from Moessbauer spectroscopy and perturbed angular correlation studies is reviewed. The implications of the reported experimental work for models of the chemical reactions occurring following the (n,γ) reaction are discussed. (auth)

Separation Processes

Refer also to abstracts 43933, 43939, 43950, 43954, 43988, 43989, 43995, 44022, 44034, 44092, and 44224.

44060 (ANL–7650, pp 1-14) FUEL-CYCLE TECHNOLOGY. (Argonne National Lab., Ill.).

Topics covered include: decladding by liquid metals; high-temperature mixer-settler development; pyrochemical purification of ^{238}Pu; reprocessing fast breeder reactor fuels; fluidization technology; and conversion of fast breeder oxide fuels to carbide fuels. (M.C.G.)

44061 (CEA-N–1292, pp 29-52) ROUTINE ON-LINE ANALYSIS. STATE OF PROGRESS OF STUDIES AND TESTS ON DECEMBER 31, 1968. Dedaldechamp, P.; Le Bouhellec, J. (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

At the pilot spent fuel processing plant a number of measurement instruments were successfully tested under industrial conditions. The radiochemical measurements carried out include ^{233}U determination, Pu and Np detection, ^{85}Kr detection and γ counting of distillates from the fission product solution concentration evaporator. A gamma absorptiometer for thorium determination control was tested. A Beckman industrial conductometer was installed on the solutions undergoing concentration in the 3 EP line evaporator. A Foxboro monitoring apparatus based on the measurement of the dielectric constant of a liquid was adapted to the determination of the percentage of TBP in the solvent used as extraction agent in irradiated uranium processing. (France)

44062 (CEA-N–1292, pp 53-106) RESULTS OF ROUTINE ON-LINE ANALYSIS IN USE AT UP1. Reneaud, J. M.; Chabert, J.; Hugony, P. (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

Measurement of the Pu concentrations and of the activities of the solutions are essential in reprocessing plant operation. Alpha, γ, and neutron counters are the main on-line instruments used and their installation, after long and careful study, has led to a considerable economic improvement and greater safety. Important parameters involved in the piloting of the various units have been

determined from physical or physicochemical measurements. Acidimeters, pH meters, conductometers, and densimeters were used, almost all of which were fitted onto facilities already in service. The apparatus having been designed in the laboratory, its adaptation to active units required lengthy study since it had to have the following qualities: good resistance to corrosion and radiations, ease of maintenance, repair and decontamination, possibility of inspection, standardization, and minimum cost. (France)

44063 (CEA-N-1292, pp 139-59) REPROCESSING OF ENRICHED URANIUM ALLOYS. ON-LINE ANALYSES AND CONTROL IN THE FACILITY "ATTILA". Manevy, G.; Mantega, M.; Marlin, H. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Proceedings of the meeting on automatic chemical control, Fontenay-aux-Roses, France, May 1970.

On-line analyses enable the course of the various operations to be followed and guided according to the results. Chlorination is checked by measurement of the differential thermal conductivity and fluorination by means of two techniques: gas phase chromatography and counting of radioactive volatile fluorides. Apart from the hydrogen measurement apparatus, the analytical equipment is housed in a laboratory underneath the Attila cell. The processes and apparatus used are described. (France)

44064 (DOCKET-50201-43) WEST VALLEY REPROCESSING PLANT. Head End Ventilation System. Final Safety Analysis Report, Suppl. 2. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 4 Sep 1970. 13p. Dep. CFSTI.

Information is presented in support of the safety analysis of the head-end ventilation system. Operation of the filter system, loss of function, explosion in the head end, flow balancing, and other components and operations are discussed. (M.C.G.)

44065 (DP-1222) SEPARATION OF ^{210}Po FROM BISMUTH BY LIQUID METAL DISTILLATION. Bradley, R. F.; Landon, L. F.; Gibson, G. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jun 1970. Contract AT-(07-2)-1. 39p. Dep. CFSTI.

The research and development tests on laboratory and plant-scale semiworks equipment that has established the engineering feasibility of using liquid metal vacuum distillation to separate up to 10 kg ^{210}Po/year from irradiated bismuth are summarized. (auth)

44066 (IN-1402) EVALUATION OF ADSORBENTS FOR PURIFICATION OF NOBLE GASES IN DISSOLVER OFF-GAS. Lewis, L. C. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 12p. Dep. CFSTI.

The adsorption capacities for nitrous oxide, nitrogen, dioxide, and krypton on a series of solid adsorbents were determined. These adsorbents (alumina gels, silica gels, and molecular sieves) are potentially useful in the off-gas decontamination systems of nuclear plants. One silica gel and one type of molecular sieve, Norton Zeolon, had the desirable properties of high capacity for oxides of nitrogen and a low capacity for krypton. This molecular sieve was also resistant to damage by hot nitric acid. (J.G.B.)

44067 (KFK-1025) PROBLEMS OF IODINE SEPARATION FROM THE PROCESS OFF-GAS OF THE REPROCESSING FACILITY. Roth, B. F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Dec 1969. 23p. (In German). Dep. CFSTI (U. S. Sales Only).

Removal of ^{131}I from process gas can be achieved up to 99.99%. Processing of fuel elements from thermal reactors with the usual storage time of 140 to 160 days can be performed easily with the same high efficiency. Fuel elements from fast sodium reactors present a certain problem. Because of the high plutonium content, storage times as low as 30 days are desirable. At such short times, iodine retention must be increased from 10^4 to 10^7. This can be achieved by adding an additional head-end-step to the gas removal facility as presently studied at ORNL. (tr-auth)

44068 (NP-18306) THE NEUTRALISATION SELF-SOLIDIFICATION PROCESS (N.S.S.P.). STATUS OF THE DEVELOPMENT WORK. Hild, W.; Lazzaretto, G. F.; Hasler, A.; Lopez-Menchero, E. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Jun 1968. 90p. (ETR-258). Dep. CFSTI (U. S. Sales Only).

A preproject for an NSSP (Neutralization Self-Solidification Process) plant treating Eurochemic MLW (medium level waste) is described. An economic evaluation of this plant preproject shows that optimum working conditions are obtained for a plant capacity of 1 m^3 MLW per hour. At this capacity the treatment costs amount to 434 \$/m^3 or $3.02 \cdot 10^{-2}$ mill/kW-hr if the treatment costs are related to the electrical energy produced. In order to provide a further basis for comparing the NSSP treatment cost, another potential MLW treatment approach, the homogeneous incorporation into bitumen, was evaluated. Treatment costs for both processes are equal if \$85.00 storage containers are used (434 \$/m^3). Due to the fact that the bitumen approach leads to a solid waste volume twice as high as that obtained with NSSP, the latter is favored if more expensive storage containers are used, whereas cheaper containers favor bitumen incorporation. A description of the testing, carried out on NSSP equipment up to May 1968, is given. Long-term tests with a simplified NSSP pilot installation showed that the industrial self-cleaning screw conveyor evaporator used does not prevent incrustation of the evaporator surface. Three improved NSSP approaches, originating from the results of the development work, are described. They are characterized according to the equipment used in the final concentration step: drum drier; wiped thin-film evaporator; and mechanical deliquefication. These, due to inherent process simplifications, should lead to treatment costs that are lower than, or at most equal to, those obtained in the preproject. (auth)

44069 (ORNL-4583) CHEMICAL RECOVERY AND REFINEMENT PROCEDURES IN THE ELECTROMAGNETIC SEPARATION OF ISOTOPES. Davis, W. C. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 108p. Dep. CFSTI.

Specific procedures for the recovery and refinement of electromagnetically separated isotopes are given. Appendices on health and safety hazards, removal of impurities, and special preparations from inventory forms of isotopes are included. (J.G.B.)

44070 (ORNL-tr-2358) PRELIMINARY CALCULATIONS OF THE HYDROCYCLONE CONTACTOR TYPE M.P.H. Hoffmann, P. M. (Institute of Nuclear Research, Warsaw (Poland)). Translated for Oak Ridge National Lab., Tenn., from report INR-1068. 19p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 49892.

44071 SORPTION OF CATIONS FROM A COMPLEXING MEDIUM. VII. SEPARATION OF CATIONS IN A STRONGLY ACID MEDIUM. Kratochvil, V.; Povondra, P.; Sulcek, Z. (Geologisches Zentralinstitut, Prague). Collect. Czech. Chem. Commun.; 35: 233-41(Jan 1970). (In German).

Distribution coefficients were determined for 19 elements in cation exchange with diluted EDTA in a medium of 0.03 to 0.08 M HNO_3. In accordance with dependency of distribution coefficients on pH, the 19 elements could be subdivided into four distinct groups. The decisive factors for degree of sorption proved to be the stability constant of the chelate and selectivity of the element for the employed cation exchanger. Based on differences of distribution coefficients, two procedures are described: one for the separation of cobalt from nickel; and the other for separation of chromium from aluminum and iron. (tr-auth)

44072 EXTRACTION OF H_2SO_4 AND U(VI) BY SOLUTIONS OF TRIOCTYLAMINE. Kuzina, M. G.; Lipovskii, A. A. Radiokhimiya; 12: 393-6(1969). (In Russian).

It was established that the presence of water in organic solutions changes not only the degree of association of trioctylamine (TOA) sulfate, but has an effect on the symmetry of the sulfate group. The presence of H_2SO_4 in organic phase in quantities that exceed those necessary for formation of $TOAHHSO_4$, causes changes in the form of the extracted uranium compound. (tr-auth)

44073 EFFECT OF STERIC HINDRANCES ON THE EXTRACTION CAPABILITY AND SELECTIVITY OF AMINES. Shmidt, V. S.; Shesterikov, V. N.; Mezhov, E. A. Radiokhimiya; 12: 399-401(1969). (In Russian).

It was found that, for the extraction of HNO_3, Np(IV), and Pu(IV) from nitrate and Pu(IV) from HCl solutions by salts of tertiary alkylamines with a chain length above C_{10}, linear logarithmic relations of the extraction constants to the steric constant of the substitute group (E_s) were precluded. The steric hindrances of the substitute groups added to the nitrogen atoms of the amines were characterized. The selectivity of the extraction increased with increasing E_s for the extracted compounds with identical solvate numbers and decreased with increasing E_s in the case where the weakly extracted compound had a smaller solvate number. (tr-auth)

44074 PURIFICATION OF ANHYDROUS URANIUM TRICHLORIDE BY THE METHOD OF VACUUM SUBLIMATION. Tarasova, L. A.; Rachevi, V. V.; Pavlova-Verevkina, A. I. Radiokhimiya; 12: 405-7(1969). (In Russian).

On the basis of results obtained, vacuum sublimation is recommended as an efficient method for preparation of pure anhydrous uranium trichloride. (tr-auth)

44075 EXTRACTION OF MOLYBDENUM FROM HYDROCHLORIC ACID SOLUTIONS BY O,O,S-TRIBUTYL DITHIOPHOSPHATE. Busev, A. I.; Rodionova, T. V.; Al'vares-Eskartin, L. A. (Moscow State Univ.). Zh. Neorg. Khim.; 15: 1624-7(Jun 1970). (In Russian).

The extraction of pentavalent and hexavalent molybdenum from solutions of HCl by the O,O,S-tributyl ester of phosphorodithioic acid was studied. Mo was most completely extracted from 7 mol and above HCl solutions. Hexavalent Mo is partially reduced to pentavalent Mo on extraction. The extracted form of Mo(V) is the acid $H_2(MoOCl_5)$, solvated by two molecules of O,O,S-tributyl dithiophosphate. (tr-auth)

44076 EFFECT OF RESIN CROSS-LINKING ON THE ANION-EXCHANGE SEPARATION OF RARE EARTH–EDTA COMPLEXES. Dybczynski, Rajmund (Inst. of Nuclear Research, Warsaw). J. Chromatogr.; 50: 487-503(12 Aug 1970).

The anion exchange separation of rare earth complexes with EDTA on Dowex 1 resins with 2, 4, 8, 10, and 16 nominal cross-linking, respectively, was investigated with loads at tracer levels. Selectivity coefficients, separation factors, plate heights, and resolutions for adjacent peaks were calculated from the elution curves. Although the separation factors increased rather uniformly with the increase in resin crosslinking, the best separations were obtained with Dowex 1 X_4 due to the most promising value of the plate height. Plate height, which was the lowest for the X_4 resin, was found to increase both with increase and decrease of resin cross linking. A change from an X_4 to an X_{16} resin resulted in a drastic increase of plate height of nearly two orders of magnitude. It was found that the results obtained cannot be interpreted on the grounds of the classical Glueckauf equation. The introduction of a new term, accounting for longitudinal diffusion in the resin phase, into Glueckauf's equation is suggested and the qualitative agreement between theoretical prediction and experimental data was demonstrated. The existence of a sieve effect in the case of the anion exchange of rare earth complexes with EDTA on highly cross-linked resins was also pointed out. (auth)

44077 PROCESS FOR THE RECOVERY OF FISSILE MATERIALS FROM CHEMICAL DECANNING SOLUTIONS. (to Commissariat a l'Energie Atomique). British Patent 1,200,579. 29 Jul 1970. Priority date 20 Aug 1968, France.

A process of selective crystallization is described for separating the salts of canning metals from salts of fissile materials in solutions originating from the attack of metal reactor fuel cans with dilute HNO_3. The nitrates of the canning metals are crystallized and the nitrates of the fissile materials remain in solution for passage to an installation where the fissile material is recovered. (B.L.M.)

44078 MEMBRANES FROM CELLULOSE AND CELLULOSE DERIVATIVES. Symposium Held at Minneapolis, Minnesota, April 16–17, 1969. Turbak, Albin F. (ed.). Applied Polymer Symposia, No. 13. New York; John Wiley and Sons, Inc. (1970). 346p. $135.00 per volume. (CONF-690444).

Twenty-two articles are included; one was abstracted separately in NSA. The remaining 21 articles are included under two general sections: membranes for reverse osmosis and membranes for hemodialysis and ultrafiltration. (P.C.H.)

For an abstract of one paper see: 44035.

44079 URANYL DI-N-BUTYL PHOSPHATE. Krutikov, P. G.; Solovkin, A. S. Zh. Neorg. Khim.; 15: 1610-13(Jun 1970). (In Russian).

The composition of uranyl di-n-butyl phosphate, formed on mixing solutions of $UO_2(NO_3)_2$ and DBP (dibutyl phosphate) in 0.2 or 6 mole aqueous solutions of HNO_3, was studied. A solid amorphous light-yellow (almost white) precipitate with the composition UO_2A_2 was isolated from 0.2 mole HNO_3. Dark-yellow viscous liquids were isolated from 6 mole HNO_3 and, after washing with water in air, they were transformed into a vitreous mass, corresponding to the composition $UO_2(NO_3)(HA_2)$, $UO_2(NO_3)(HA_2)(HA)_2$, or their mixtures. The possible extraction of uranyl from nitrate media by DBP is considered. (tr-auth)

44080 IMPROVEMENTS IN OR RELATING TO THE SEPARATION OF RARE EARTH ELEMENTS. Crouch, Eric Arthur Crouch (to United Kingdom Atomic Energy Authority). British Patent 1,197,491. 8 Jul 1970. Filed 26 May 1967.

Reference is made to an ion exchange technique using 1-hydroxyethylidene-1:1-diphosphonic acid as eluant for separation of rare earths. Elution may be carried out at 85 to 100°C, and the phosphoric acid solution is chosen so as to have the appropriate molarity to elute the required rare earth elements in a convenient volume. Use of 0.1M phosphoric acid will elute the rare earths Dy to Sm in about seven column volumes, and 0.13M acid will elute Pm to La in a similar volume. No pH adjustment of the acid is required as it is essentially a strong acid. The phosphoric acid forms complexes with the rare earths, and these may be precipitated as insoluble ammonium salts on neutralizing the eluate with NH_4OH and heating. An example of the application of the technique is described in detail. (auth) (UK)

44081 EXTRACTION OF URANYL ACETATE AND SULPHATE BY TRIISO-OCTYLAMINE. Vieux, Aliette S.; Lumu, F. R.; Krivanek, M. (Univ. of Lovanium, Kinshasa, Congo). pp 525-33 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB–233; CONF-690711.

With the aim of studying uranyl acetate and sulfate extraction by triisooctylamine in solutions of benzene and xylene, the effect of the acidity of the aqueous phase on the extraction yield was examined and the yield found to be dependent on acidity. The concentrations of free amine, sulfate, and bisulfate in the organic phase were determined in a sulfuric acid medium. The complexes formed between the amine, and acetic acid, and the uranyl acetate at the acid concentration giving maximum yield were found to have the same formulas in the two solvents. The results obtained in a sulfuric acid medium for three experimental groups (solvent, xylene, and benzene, $H_2SO_4 = 10^{-1}$ N and xylene, $H_2SO_4 = 5 \times 10^{-1}$ N) indicate a general formula $[(R_3NH^+)_2\ [UO_2(SO_4)_2]^{2-}]$, whereas it is difficult at present to interpret the results obtained in a benzene medium at 4×10^{-1} N acidity. The formula is arrived at by varying the partition coefficient as a function of the free amine salt concentration. (auth)

44082 ION FOCUSING BY ELECTROPHORESIS. Deelstra, H.; Dufonteny, L. (Univ. Officielle, Bujumbura, Burundi). pp 543-8 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB–233; CONF-690711.

A method of separating ions by electrophoresis is described. It was previously developed by Schumacher. This method differs from conventional electrophoresis in the use of a high potential, in the extreme short duration of the process (separation only takes a few minutes), and above all in the superimposition of a complexing agent gradient on the electric field gradient. The very short duration of the process makes it possible to demonstrate not only the phenomenon of conventional electrophoresis but also the properties of complexes, such as the difference between their stabilities. In addition, ion focusing by electrophoresis is a micromethod applied in investigating for several cations and can be used as an introduction to qualitative analytical chemistry. (auth)

44083 EXTRACTION SEPARATION OF NIOBIUM AND TANTALUM FROM TARTARIC ACID SOLUTIONS BY A CHLOROFORM 8-HYDROXYQUINOLINE SOLUTION. Pyatnitskii, I. V.; Sereda, E. S. (Kiev State Univ.). Zh. Anal. Khim.; 25: 1552-7(Aug 1970). (In Russian).

The dependence of the distribution of niobium and tantalum between an aqueous solution of tartaric acid and chloroform solution of 8-hydroxyquinoline has been found on the basis of the instability constants of the niobium and tantalum tartarate complexes and the conditional distribution constants of their 8-hydroxyquinolinates. It was found that their separation under the conditions of extraction equilibrium is impossible. The rate of the extraction of 8-hydroxyquinolinates from tartarate solutions during the separation of niobium and tantalum is of great importance. Optimum conditions have been established for separating commensurable amounts of niobium and tantalum: pH 5, 0.1 M solution of tartaric acid and 8-hydroxyquinoline. (auth)

44084 SEPARATION OF PROTACTINUM FROM ZIRCONIUM, NIOBIUM, TANTALUM AND OTHER ELEMENTS BY EXTRACTION WITH TETRAPHENYL PHOSPHONIUM CHLORIDE. Davydov, A. V.; Palshin, E. S. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 25: 1558-62 (Aug 1970). (In Russian).

A study has been made of the extraction of protactinium, zirconium, niobium and tantalum with a $(C_6H_5)_4PCl$ solution from $H_2C_2O_4$ solutions and from $HCl-H_2C_2O_4$ solutions. Niobium (tantalum) and zirconium form mixed oxalate-chloride complexes which are not extracted with the above reagent. Protactinium is separated from zirconium, niobium, and tantalum by its extraction from a 7 M HCl–0.3 M $H_2C_2O_4$ solution. (auth)

44085 EFFECT OF pH VALUES ON RADIONUCLIDE SORPTION BY ANION EXCHANGERS. Rauzen, F. V.; Vedishcheva, T. S. At. Energ. (USSR); 29: 21-6(Jul 1970). (In Russian).

The effects of pH values on radionuclide sorption by weak-base anion exchange resins is reported. The sorption by weak-base resins was found to depend on the ratio of concentration of hydrogen ions to that of anion in the solution rather than pH. The base concentrations needed for recovery of ion exchange capacity of AN-31, AN-22, AV-16, and AV-17 resins are estimated. (auth)

44086 CATION EXCHANGE SEPARATION OF PROTACTINIUM FROM TANTALUM WITH SULFURIC ACID-ALCOHOL MIXED SOLVENT SYSTEM. Chen, Ying-mao; Tsao, Fu-pao (National Taiwan Univ., Taipei). J. Chin. Chem. Soc. (Taiwan); 17: 81-98(Jun 1970).

Distributions of protactinium and tantalum between strongly acidic cation exchange resin and sulfuric acid–mixed organic solvent system were studied with ^{233}Pa and ^{182}Ta as radioactive tracers. Methyl, ethyl, and isopropyl alcohols were used as miscible organic solvents and Dowex 50 W-X 2, Dowex 50 W-X 12, Bio Rad AG 50 W-X 4, and AG 50 W-X 12 were used for different cross linking cation exchange resins. Distribution ratios were plotted against acidities by keeping compositions constant or against compositions by keeping acidities constant. From these plottings, different trends of these two metals were found. With the use of the property of especially strong absorption of protactinium in methyl alcohol solution by resin having higher degree of cross linking, AG 50 W-X 12, tantalum could be completely separated from protactinium. (auth)

44087 HYDROMETALLURGICAL INVESTIGATIONS ON URANIUM ORES FROM GEBEL KATRANY (FAIYUM, UAR). Zaki, M. R.; Farah, M. Y.; Shakir, K. (Atomic Energy Establishment, Inshas, United Arab Republic). Z. Erzbergbau Metallhuettenw.; 22: 436-41(1969). (In German).

The yield of uranium from Gebel Katrany ore was studied on a laboratory scale. Leaching experiments are described, and various factors affecting optimum extraction are considered. Yields of 97% uranium were obtained by using a mixture of sulfuric acid with 5% nitric acid. (tr-auth)

44088 DISTRIBUTION STUDIES BETWEEN THENOYLTRIFLUOROACETONE (TTA) IN METHYL ISOBUTYL KETONE (MIBK) AND AQUEOUS SOLUTIONS USING RADIOTRACERS OF GROUP II AND GROUP III ELEMENTS. Jackson, W. Morrison; Gleason, Geoffrey I.; Hammons, Percy J. Jr. (Oak Ridge Associated Universities, Tenn.). Anal. Chem.; 42: 1242-6(Sep 1970).

Using a procedure designed to yield distribution coefficients which can be quantitatively compared, 13 Group II and Group III elements were studied. Under standard conditions a radiotracer of the element of interest was distributed between an aqueous phase and an organic phase consisting of 0.1M 4,4,4-trifluoro-1-(2-thienyl)-1,3-butanedione(TTA) in 4-methyl-2-pentanone(MIBK). The distribution coefficients were computed from the ratio of activity in the organic phase to that in the aqueous phase. By varying the pH of the aqueous phase, distribution coefficients within the range of 10^{-3} to 10^{3} were obtained. From the data, pH conditions can be selected to give single stage separation factors of 1000 or greater between the following element pairs: Ca–Sc, Ca–Y, Ca–La, Zn–Sc, Sr–Sc, Sr–Y, Sr–La, Cd–Sc, Cd–Y, Cd–In, Cd–La, Ba–Sc, Ba–Y, Ba–La, Sc–Y, Sc–In, Sc–La, Sc–Tl, Y–Tl, In–Tl, and La–Tl. (Parent–daughter radioisotope pairs are underlined.) Certain system limitations were found for beryllium, gallium, and mercury. (auth)

44089 STUDIES OF THE ALKALINE EARTH COMPLEXES IN VARIOUS SOLUTIONS. V. CALCIUM(II) AND STRONTIUM(II) COMPLEXES WITH CARBONATE IONS IN 1M SODIUM CHLORIDE MEDIA. Hasegawa, Yuko; Kawashima, Hiroshi; Sekine, Tatsuya (Tokyo Univ.). Bull. Chem. Soc. Jap.; 43: 1718-22(Jun 1970).

The complex formation of calcium(II) and strontium(II) with carbonate ions in 1M sodium chloride media at 25°C was determined by a liquid-liquid distribution method. The metal ions in the aqueous phase were extracted with a mixture of benzoylacetone and tributyl phosphate in hexane as adduct chelate complexes. The distribution ratio was determined by radiometry as a function of the carbonate-ion concentration in the aqueous phase. The decrease in the metal distribution caused by the addition of carbonate ions to the aqueous phase was explained in terms of the complex formation, and the stability constants were determined from these data by a "curve-fitting" method. It was concluded from the results that the stabilities of these complexes are about the same magnitude of those of the sulfate complexes of these metal ions and that the concentration of the carbonate complexes in usual natural waters is probably negligibly small. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 44025, 44127, 44134, 44136, 44144, 44382, and 46108.

44090 (AECL–3557) PERCH LAKE EVAPORATION STUDY. Barry, P. J.; Merritt, W. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb 1970. 16p. (SM–129/10; CONF-700328–2). Dep. CFSTI (U. S. Sales Only). AECL $0.50.

From Conference on the Use of Radioisotopes in Hydrology, Vienna, Austria.

The primary purpose of the Perch Lake project is to exploit the use of radioactive tracers in the study of all aspects of the hydrological cycle in a small, well-defined basin. Within this broad objective a number of individual studies are being conducted of which one, the use of tritiated water vapor for the study of evaporation mechanisms in a natural setting, is believed to be unique. Other studies include the determination of the water, tritiated water, energy and trace element budgets of the lake of which the first three complement the use of tritiated water vapor to study basic evaporation mechanisms. Radioactive tracers have been used particularly for estimating the ground water components of the water and tritium budgets. Ground-water flows predicted by the use of conventional hydrological techniques as well as various new flow models are being compared with the results obtained using radioactive tracers. (auth)

44091 (BARC–478) GROUND WATER MOVEMENT STUDIES IN RADIOACTIVE WASTE STORAGE SITE: TROMBAY. Godse, V. B.; Singh, Mahesh (Bhabha Atomic Research Centre, Bombay (India)). 1970. 14p. Dep. CFSTI (U. S. Sales Only).

Ground-water movement studies at the radioactive waste storage site near Trombay, India were carried out by injecting suitable tracer dye in a centrally located well and tracing its movement in the surrounding wells. These experiments indicated the direction and rate of movement of ground-water in that particular zone. It was observed that the general direction of ground-water movement is southward leading to the bay with a velocity varying from 0.8 to 1.2 ft/day. However, a secondary ground water movement was also observed along the joint patterns of the rocks in east-west direction with a velocity varying from 0.9 to 5.6 ft/day. The experiments indicated that the movement of radioactivity during an accidental release from the contained facility of the storage site is likely to move towards the Trombay Bay. As the average velocity of ground water is very slow, it will provide an additional time factor for the active ions to reach the bay. (auth)

44092 (CEA-CONF–1528) SELECTION CRITERIA FOR SITING OF REPROCESSING PLANTS IN EUROPE. Sousselier, Y. (Commissariat a l'Energie Atomique, Paris (France)). 14p. (CONF-691102–24). Dep. CFSTI (U. S. Sales Only).

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

Results of criteria evaluation lead to the conclusion that in Europe, given the almost total lack of desert-like suitable areas, seaside sites in particular peninsulas, are likely to be favored. European geography is most suitable for such sitings. Plants which are to be built in Europe at the rate of one plant every three years from 1980 onwards will be established in accordance with these criteria and with the best possible economic factors. This tends to prove that the reprocessing industry has now come of age, that we may now select a site by paying more attention to economic factors than to preventing radiological consequences on the environment. (J.R.D.)

44093 (CONF-700810–12) RESEARCH ON THE MAXIMUM RADIOACTIVE BURDEN OF SOME GERMAN RIVERS. Feldt, W. (Bundesforschungsanstalt fuer Fischerei, Hamburg (West Germany). Isotopenlaboratorium). [1965]. 14p. (SM–146/29). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The maximum radioactive burden of a river restricts the number of nuclear power stations and their release of activity. The methods and ideas used to get relevant information before a nuclear power station starts to operate are described. The resulting data make effective monitoring possible. The concentration factors for fishes and water plants are given with respect to the elements Sr, Cs, Mn, Co, Zn, Cu and Fe in the rivers Ems, Weser and Elbe. The choice of some biological indicators for monitoring purposes is interpreted. Problems of measurements are discussed in the case of accidental release of higher activities. (auth)

44094 (CONF-700810–29) THERMAL STANDARDS IN THE UNITED STATES OF AMERICA. Mount, Donald I. (National Water Quality Lab., Duluth, Minn.). [nd]. 7p. (SM–146/15).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Temperature standards specifying permissible water temperatures for interstate rivers and lakes of the United States have been established. Mostly they are based on the uses of the water that now exist, or may exist in the future. Usually, the protection of desirable aquatic life is most limited. Standards for aquatic life must ensure a seasonal temperature cycle, and so twelve maximum monthly temperatures are the minimum to describe desired conditions. In streams a 5°F rise may be permitted as long as the resulting temperature does not exceed the appropriate monthly maximum. In lakes a 3°F rise may be used with an additional requirement that the hypoliminion cannot be warmed or changed in volume. Stricter restrictions are applied to lakes in order to reduce the algal growth problem. Mixing zones pose a difficult regulatory problem. They are difficult to restrict as to size and shape especially because the effects of mixing zones on receiving water depend, in part, on the number of mixing zones and the size of the lake or river. There seems to be no simple way to establish them but certain guidelines can be used: lethal concentrations should not be permitted. The size should be defined and fixed and objectionable nuisances such as undesirable vegetation or debris should not be permitted. Where cooling devices are required, the standards do not specify the type to be used. The frequency that devices will not meet the standards has not been well defined except in a general way. Obviously the acceptable probability depends in part on the value of the receiving water and the probable damage if the standards are exceeded. If no safety margin is permitted, standards must be more complex in order to ensure acceptable conditions. (auth)

44095 (ORO–3622–9) ABSOLUTE DATING OF OCEAN SEDIMENTS BY USE OF $^{230}Th/^{231}Pa$ RATIO AND GEOCHEMICAL STUDIES OF LIMITING BOUNDARY CONDITIONS WITH SPECIAL ATTENTION TO EXOTIC ENVIRONMENTS. Annual Progress Report. Rona, Elizabeth (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). Aug 1970. Contract AT(40-1)-3622. 7p. Dep. CFSTI.

One deep sea core from the central Caribbean was dated by ^{14}C and $^{231}Pa/^{230}Th$ methods. The ages obtained were in good agreement with the ages previously obtained for other cores. Sediment cores from the Cariaco Trench were analyzed, and a high U concentration was found. Fossil marine carbonates from the Afar depression between Ethiopia and the Red Sea were studied to develop a geochronology of the region. Tenative ages of the deposits are given. (L.C.L.)

44096 (SWRHL–74-r) SOIL SURVEY OF AREA 18, NEVADA TEST SITE. Leavitt, V. D. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jul 1970. 119p. Dep. CFSTI.

This soil survey of Area 18 of the Nevada Test Site was conducted to gather information on the soil and vegetation of the Area 18 grazing range of the Atomic Energy Commission's (AEC) beef herd. Physical and chemical analyses were performed on the soils. Twenty soil series descriptions were written for the different types of soils. Soil maps are included. (auth)

44097 (TRC–7743-341-a) A SYSTEMS ANALYSIS OF AQUATIC THERMAL POLLUTION AND ITS IMPLICATIONS. VOLUME I. SUMMARY REPORT. Cheney, Philip B.; Smith, Frank A. (Travelers Research Corp., Hartford, Conn.). Jan 1969. 30p.

For National Coal Policy Conference, Inc., Washington, D. C.

A study was performed to: provide a broad system overview of the production and disposal of waste heat within the thermoelectric generation process; review the state of knowledge with regard to aquatic thermal effects; highlight the considerations that must enter the systematic appraisal and evaluation of the problem; and form the basic framework within which such an evaluation can proceed. A summary is presented of: steam-electric technology and the accompanying production of waste heat; methods and costs of disposing of the waste heat; physical behavior and effects of the waste heat discharged into a water body; ecological effects of waste heat in a water body; social considerations of these effects and the

potential for social control; and cost implications for the utility industry and the energy-fuel industry of a range of possible regulations. Better methods are required for predicting the behavior of thermal discharges in a water body, for determining the ecological changes caused by temperature changes, and for estimating the values society places upon certain specific ecological conditions. (auth)

44098 (TRC-7743-341-b) A SYSTEMS ANALYSIS OF AQUATIC THERMAL POLLUTION AND ITS IMPLICATIONS. VOLUME II. TECHNICAL REPORT. Cheney, Philip B.; Smith, Frank A.; Brush, Robert O.; Pelton, Douglas J.; Kangos, James D. (Travelers Research Corp., Hartford, Conn.). Jan 1969. 141p. For National Coal Policy Conference, Inc., Washington, D. C.

A study was performed to: provide a broad system overview of the production and disposal of waste heat within the thermoelectric generation process; review the state of knowledge with regard to aquatic thermal effects; highlight the considerations that must enter the systematic appraisal and evaluation of the problem; and form the basic framework within which such an evaluation can proceed. The subjects discussed include: steam-electric technology and accompanying production of waste heat; methods and costs of disposing of the waste heat; physical behavior and effects of the waste heat discharged into a water body; ecological effects of waste heat in a water body; social considerations of these effects and the potential for social control; and cost implications for the utility industry and the energy-fuel industry of a range of possible regulations. (auth)

44099 (UCRL-50915) MINERAL COMPOSITION, CO_2 CONTENT, AND GRAIN DENSITY OF DRILL HOLE SAMPLES FROM YUCCA FLAT, NEVADA TEST SITE. Ramspott, L. D.; Braun, R. L.; Wadleigh, W. F. (California Univ., Livermore. Lawrence Radiation Lab.). 11 Aug 1970. 15p. Dep. CFSTI.

Mineral composition, CO_2 content, and grain density have been determined for 148 samples from 108 drill holes in Yucca Flat, Nevada Test Site. The amounts of calcite, dolomite, and quartz were quantitatively determined by x-ray diffractometry using an internal standard. All other minerals were identified, and qualitative estimates of the x-ray intensities of zeolite, feldspar, and illite are given. The mean weight-percent values for 119 alluvium samples are: calcite 5.9, dolomite 4.5, and CO_2 4.77. The median values for the same samples are: calcite 2.5, dolomite 1.5, and CO_2 3.60. The modal classes are: calcite 1-2 (wt%), dolomite 0-1, and CO_2 0-1. Although two-thirds of the holes had only cuttings samples for the alluvium interval, analysis of size fractions of suitable samples indicates that cuttings samples provide a usable indicator of the carbonate content of the original rock. In general, grain density does not correlate quantitatively with any one mineral, but in a suite of samples from one drill hole the correlation coefficient between dolomite and grain density was 0.933. (auth)

44100 (USGS-474-34) HYDRAULIC TESTING OF WELL HTR-3 IN CENTRAL NEVADA. Central Nevada-35. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. 24p. Dep. CFSTI.

An analysis of data obtained during hydraulic tests in hydrologic test hole HTH-3, Little Smoky Valley, Nevada is presented. The analysis is focused primarily on determining variations in hydraulic potential in the vertical section and transmissivity, hydraulic conductivity, storage coefficient, and velocity of ground-water movement in selected intervals of anticipated high permeability. Hole HTH-3 penetrated alluvium, welded tuff, and tuffaceous sandstone and claystone. The composite water level for the interval from 1,431.6 to 1,831.5 m was 172.67 m below land-surface datum. In the tested intervals from which the data were adequate for analysis, transmissivity ranged from 9.7×10^{-1} to 2.9 m^3/day per m; hydraulic conductivity ranged from 1.0×10^{-2} to 2.3×10^{-1} m^3/day per m^2; and velocity ranged from 2.0×10^{-3} to 4.6×10^{-2} m/day. However, velocities of ground-water movement through some intervals might be significantly greater, depending on the thicknesses and effective porosities of the water-contributing fracture systems. (auth)

44101 RECONNAISSANCE RADIOMETRIC SURVEY ON THE KANMON FORMATIONS IN THE EASTERN PART OF NORTHERN KYUSHU. Kiyoshima, Nobuyuki; Harada, Tanenari; Okumura, Masataka (Geological Survey of Japan, Kawasaki). Chishitsu Chosasho Geppo; 20: 739-42(Nov 1969). (In Japanese).

A survey was carried out on the Kanmon Formations which are of Mesozoic age and are composed of shale (lower part, Wakino subgroup), andesitic lavas and pyroclastic rocks (upper part, Shimonoseki subgroup). In this reconnaissance survey, no intense radioactive anomalies were found except one that showed two or three times the natural count in the Shimonoseki subgroup. (auth) (Japan)

44102 STUDIES OF FISSION TRACKS IN ZIRCON: AGE, DISTRIBUTION, AND CONCENTRATION OF URANIUM. Nagai, Jiro. Mem. Fac. Sci. Kyoto Univ., Ser. Geol. Mineral.; 35: 119-30(Dec 1968). (In French).

The distribution of fission tracks and the concentration of uranium in zircon was studied by optical microscopy after phosphoric acid attack. The ages of rocks, granites, and gneiss were calculated from the ratio between the density of fossil fission tracks and new tracks induced by irradiation with thermal neutrons. On the zircons studied, the samples in the granites were given ages agreeing with the ages determined by classical methods of geochronology. The zonal distribution and the log normal distribution are indicated. (tr-auth)

44103 NATURAL BACKGROUND GAMMA-RAY SPECTRUM MEASURED WITH A Ge(Li) DETECTOR. Fujita, Akira; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 5-8 (1969).

Natural background gamma-ray spectra were measured with a Ge(Li) detector with high resolution in and out of a 20 cm thick iron shield cave. The background counting rate was reduced with the shielding to about one-hundredth. All the photopeaks that appear in natural background spectra are due to the natural radionuclide ^{40}K and the daughter radionuclides in uranium and thorium series. (auth)

44104 GAMMA-PHOTONEUTRON METHOD FOR LABORATORY STUDIES OF SOIL WATER. Corey, J. C.; Hawkins, R. H.; Overman, R. F. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Soil Sci. Soc. Amer., Proc.; 34: 557-60 (Jul-Aug 1970).

The gamma-photoneutron method is unique among nuclear methods used to study water movement in soil because the heavy water (^2H_2O) content of laboratory soil columns can be measured independently of bulk density of soil, soil texture, light water (^1H_2O) content, and type of clay mineral. The method requires a radioactive source that emits gamma photons in excess of 2.23 MeV and a neutron detector. The neutron detector measures photoneutrons produced when the deuterium nuclei in the gamma radiation field split into a photoneutron and a proton. The number of photoneutrons detected is linearly related to the heavy water content of the soil column. (auth)

44105 DISTRIBUTION OF URANIUM AND THORIUM IN THE PLANA PLUTON. Khisina, T.; Pavlova, M. Izv. Geol. Inst., Bulg. Akad. Nauk., Ser. Geokhim., Mineral. Petrogr.; No. 17, 33-40(1968). (In Russian).

Geochemical enrichment of U and Th in the more acid differentiates in the central part, and, especially Th, in quartz-dioritic rocks is noted. Average content of U and Th is 1.74 and 10.8 ppM, respectively, the content increasing with an increase in content of SiO_2. A correlation between U and Th content and that of TeO + MgO + CaO is also noted. (Fuel Abstr.) (TSS)

44106 USE OF $LiBO_2$ FLUX FOR K-Ar DATING. Engels, J. C.; Ingamells, C. O. Talanta; 17: 783-4(Aug 1970).

Purified vacuum-fused lithium metaborate ($LiBO_2$) was tested as a flux in the vacuum melting of mineral samples for K-Ar dating and was found to be completely compatible with typical argon extraction and analysis equipment. It was tested with gold, molybdenum, and tungsten crucible material. The technique apparently produces no adverse gaseous products to interfere with gettering materials in the argon extraction train or with mass spectrometric measurements. (UK)

44107 ISOTOPIC AGE DETERMINATIONS IN QUEENSLAND AND THEIR RELATION TO THE GEO-CHRONOLOGICAL TIME SCALE FOR THE PERMIAN. Webb, A. W. (Bureau of Mineral Resources, Geology, and Geophysics, Canberra, Australia). Spec. Pupl., Geol. Soc. Aust.; 2: 113-6(1969).

The errors and reliability of different methods of isotopic dating are reviewed. For individual age determinations on Permian rocks, the errors involved may be as high as 10 to 15 million years. Ages used in the compilation of earlier time scales for the Permian are examined from the viewpoint of analytical reliability and accuracy of the stratigraphic position assigned to the samples. Dates from eastern Queensland are quoted which indicate an age of 285 Myr for the basement below the Lizzie Creek Volcanics, about 270 Myr for the Lizzie Creek Volcanics and 240 Myr for the top of the Gyranda Formation. Analyses of numerous granitic rocks whose stratigraphical positions are not precisely known suggest that the Back Creek Group is older than 245 Myr and that the Permian-Triassic boundary is between 230 and 235 Myr old. (auth) (Australia)

44108 RADIOMETRIC METHODS IN MINERAL PROSPECTING: U. A. R. EXPERIENCE AND WIDER APPLICATIONS. El-Shazly,

E. M. (Atomic Energy Establishment, Cairo). pp 169-77 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Radiometric methods are normally used in prospecting for radioactive occurrences; however, experience shows that they may also be used as a prospecting tool for some other mineral deposits. This wider application depends on various geological, geophysical and other factors. It implies the presence of anomalous concentrations, although not particularly high, of naturally occurring radioactive isotopes with the mineral occurrences, although the type of association may be diverse. Some less abundant elements such as niobium, zirconium and rare earths are geochemically associated with uranium and/or thorium in magmatic and related processes. Anomalous concentrations of the radioactive elements are present with such less abundant elements in complex mineral associations, so that it has been possible to discover occurrences of these latter elements by radiometric methods. The association of radioactive elements with others may be mechanical as in the heavy sands where radioactive minerals such as monazite and allanite are present with other heavy minerals including ilmenite and magnetite. The discovery of or verifying the extent of the non-radioactive minerals may be done radiometrically even when the associated radioactive minerals are in smaller amounts. Some oilfields show characteristic peripheral zones of higher radioactivity surrounding low-radioactivity central areas. Other examples where radiometry may be usefully applied in mineral prospecting as in phosphates and potassium salts are also given. Possibilities of African inter-State cooperation in the wider application of radiometry in mineral exploration are justified, and means of achieving this cooperation are suggested. (auth)

44109 ON THE CONSTANCY OF THE RATE OF RADIOACTIVE DECAY. Gerling, E. K.; Ovchinnikova, G. V. (Inst. of Geology and Geochronology of the Precambrian, Leningrad). Geokhimiya; No. 8, 891-902(Aug 1970). (In Russian).

P. A. M. Dirak advanced the hypothesis in 1938 that the gravitation constant decreases in proportion to the age of the universe. If Dirak's assumption is correct, a number of other physical constants, especially constants of radioactive decay must also change with time. Thirty-six various age values of rocks dated by the U-Pb and Rb-Sr methods were considered as well as 7 anomalously high values of the K-Ar age in comparison with the U-Pb age values. A deviation from the straight line of concordant values was noted. It changes with time according to the parabolic law and this behavior may be explained by the inconstancy of radioactive decay. To confirm these observations it appears necessary to carry out further work on the comparison of age figures for old rocks by the K-Ar, Rb-Sr and U-Pb methods. (auth)

44110 RADIOACTIVITY OF RECENT VOLCANIC ROCKS OF PACIFIC ISLES. Cherdyntsev, V. V.; Senina, N. I. (Geological Inst., Moscow). Geokhimiya; No. 8, 957-70(Aug 1970). (In Russian).

The ratio of the radioisotopes in rocks of the Caucasus type, e.g., $^{238}U \geq ^{234}U > Io\ ^{232}Th\text{-}^{231}Pa$ (activity units) is characteristic of continental volcanic rocks. It corresponds to separation of the radioelements without substantial separation of their isotopes. Such was obtained at the Tahiti Isle outside the andesite ring of the Pacific. Inside this ring two types of neovolcanic rocks were found: the Fiji type: $^{234}U \geq ^{238}U$; $Io > ^{232}Th\text{-}Io\text{-}^{238}U$; $^{231}Pa\text{-}^{235}U$ (separation of isotopes) and the Oahu type: $^{234}U\text{-}^{238}U$; $Io/^{232}Th = 0.8$; $Io > ^{238}U$; $^{231}Pa > ^{235}U$ (the ratio is inverse compared with the Caucasus type). The difference is explained by interaction of the volcanic exhalation with the basaltic crust of the ocean bottom. In the early volcanic phase, rocks of the Fiji type are formed and in the latter case—rocks of the Oahu type. The maximum absolute age of the investigated rocks is in many cases the Upper-Pleistocene. The $^{234}U/^{238}U$ value reaches 3.64 ± 0.8 for one sample of deep-sea pumice. (auth)

44111 DEUTERIUM VARIATIONS IN AN ANNUAL SNOWPACK. Judy, Clark (Colorado State Univ., Fort Collins); Meiman, James R.; Friedman, Irving. Water Resour. Res.; 6: 125-9(Feb 1970).

Deuterium samples taken during the 1967 to 1968 snow year in the Rocky Mountains of Colorado indicated that metamorphism and melt of the snowpack greatly reduced the large initial variability in deuterium content of individual snowfalls. New snow values ranged from $-229‰$ to $-106‰$. D relative to SMOW (Standard Mean Ocean Water). The range in the snowpack profile on May 3, 1968, was -182 to -158. This homogenization would reduce the problems involved in following snowmelt through the hydrologic system. (auth)

44112 MULTIPLE GAMMA RADIATION LOGGING TECHNIQUE FOR IDENTIFYING LOW ATOMIC NUMBER MATERIALS. Tittman, Jay (to Schlumberger Tech. Corp.). U. S. Patent 3,521,063. 21 Jul 1970. Filed 19 Jul 1967.

A specific embodiment of the invention identifies the chemical composition of an earth formation and compensates for mudcake during well logging. The formation is irradiated with photons that have energies less than about 1 MeV. A low energy gamma radiation detector is positioned close to the gamma radiation source primarily to measure borehole parameters, while a second low energy gamma radiation detector, spaced more distantly from the gamma ray source, measures borehole characteristics and the mineral composition of the formation. The signals from the detectors are normalized and combined to produce an output that identifies formation lithology and effective mudcake thickness. (auth)

44113 URANIUM AND THORIUM IN HYDROTHERMALLY ALTERED ROCKS UNDER ACID CONDITIONS. AS EXEMPLIFIED BY SILICIFIED ROCKS FROM TATEYAMA JIGOKUDANI, TOYAMA. Imahashi, Masayuki (Tokyo Metropolitan Univ.). Nippon Kagaku Zasshi; 91: 668-9(Jul 1970). (In Japanese).

Uranium and thorium content in hydrothermally-altered rocks from the Tateyama Jigokudani hot spring area, Toyama, were determined in order to study the mobilities of these elements under acid conditions. The leachabilities of these elements were calculated on the basis of content. It was found that silica is not leachable during the alterations. The calculations demonstrated that 60% of the thorium as well as 50% of the uranium could be removed from original rocks. The mobilities of these elements under acid conditions are greater than those during weathering processes under neutral conditions. (auth)

44114 ADVANCES IN GEOPHYSICS. VOLUME 13. Landsberg, H. E.; Van Mieghem, J. (eds.). New York; Academic Press Inc. (1969). 274p.

Five papers on subjects related to recent advances in geophysics were presented. A separate abstract was prepared for one. Four were not within the scope of NSA. (L.C.L.)

For and abstract of one paper see: 44115.

44115 AIRBORNE GEOPHYSICAL METHODS. Hood, Peter (Geological Survey of Canada, Ottawa); Ward, S. H. Advan. Geophys.; 13: 1-112(1969).

Some of the airborne geophysical methods successfully developed and used in recent years are described generally and discussed critically. Airborne methods used for mineral prospecting, rather than for geodetic, military, or other applications, are emphasized and include: aeromagnetic methods, low-frequency electromagnetic methods, radiometric methods, gravity methods, and other remote-sensing methods. (L.C.L.)

44116 GIANT RADIOACTIVE HALOS: INDICATORS OF UNKNOWN RADIOACTIVITY. Gentry, Robert V. (Oak Ridge National Lab., Tenn.). Science; 169: 670-3(14 Aug 1970).

A new group of giant radioactive halos has been found with radii in excess of anything previously discovered. Since alternate explanations for these giant halos are inconclusive at present, the possibility is considered that they originate with unknown alpha radioactivity, either from isomers of known elements or from superheavy elements. (auth)

Meteorology

Refer also to abstracts 43965, 43966, and 44456—44458.

44117 (ARLV-351-12) ARL FALLOUT PREDICTION TECHNIQUES. Heffter, Jerome L. (Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.). May 1969. Contract SF 54-351. 47p. (ERLTM-ARL-13). Dep. CFSTI.

A manual prediction technique is presented for computing a fallout pattern for a single nuclear surface or air burst. The technique is based on the concept of radioactive particles that fall from a stabilized nuclear cloud, are transported by the winds, and finally deposit over an area on the ground, thus forming a fallout pattern. The computation of a fallout pattern is described in detail. (auth)

44118 (ERLTM-ARL-5) ATMOSPHERIC TRANSPORT AND DIFFUSION IN THE PLANETARY BOUNDARY LAYER. Semiannual Research Program Review, July-December 1967. Van der Hoven, I. (ed.) (Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.). May 1968. 60p. Dep. CFSTI.

Developments are reported for studies on: low altitude con-

stant volume balloon (tetroon) trajectories; vertical variation of lateral turbulence; wind persistence probability; radar-tetroon-transponder system; computer program for turbulence studies; meso-micro studies; and relative diffusion and deposition of uranine dye and radioiodine. (P.C.H.)

44119 (ERLTM-ARL-14) ATMOSPHERIC TRANSPORT AND DIFFUSION IN THE PLANETARY BOUNDARY LAYER. Semiannual Research Program Review, July–December 1968. Van der Hoven, I. (ed.) (Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.). Jun 1969. 44p. Dep. CFSTI.

Developments are reported for studies on: low altitude constant volume balloon (tetroon) trajectories; wind measurements on a tall tower in rough and inhomogeneous terrain, and mixing-length hypotheses at Air Resources Laboratories, Silver Spring, Maryland; and diffusion and deposition comparison; mesoscale wind field, transport, and diffusion; feasibility of an automatic tetroon release system; statistical technique for surface wind forecasting; hemispheric dispersion; deposition and depletion; and turbulence analysis at National Reactor Testing Station. (P.C.H.)

44120 (ERLTM-ARL-20) ATMOSPHERIC TRANSPORT AND DIFFUSION IN THE PLANETARY BOUNDARY LAYER. Semiannual Research Program Review, July–December 1969. Van der Hoven, I. (ed.) (Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.). Jun 1970. 65p. Dep. CFSTI.

Developments are reported for studies on: mesoscale Lagrangian research using tetroon flights; prediction of wind fields by statistical techniques; mixing length hypotheses; urban wind measurements on a tall tower; mesoscale transport results from 1969 data; accuracy testing of random-to-grid interpolation of mesoscale winds; kinematic modeling of mesoscale flow; efficient map types; forecast verification; turbulent wind velocity components from hot wire arrays; environmental chamber; hemispheric dispersion; and diffusion and deposition. (P.C.H.)

44121 (HASL-217) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, SEPTEMBER 1, 1969–DECEMBER 1, 1969. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jan 1970. 410p. Dep. CFSTI.

The quarterly summary report for the Health and Safety Laboratory Fallout Program is presented. Separate abstracts were prepared for the nine sections. (D.H.M.)

For abstracts of individual sections see: 43964, 44122, 44123, 44145, 44146, and 44455–44458.

44122 (HASL-217, pp I.149-54) INDUCED RADIOACTIVITY IN RECENT ATMOSPHERIC TESTS. Krey, Philip W.; Kleinman, Michael T.; Sanderson, Colin; Rosa, William (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program Quarterly Summary Report.

Measurements on the January 1968 Project Airstream samples taken in the Northern Hemisphere showed considerable amounts of ^{55}Fe. The February 1969 samples in the Southern Hemisphere showed the presence of ^{57}Co and ^{58}Co. The timing and location of these activation products are consistent with their production in the June 1967 Chinese nuclear test and 1968 French thermonuclear tests, respectively. (D.H.M.)

44123 (HASL-217, pp III.14-19) SITE SURVEY AND METEOROLOGY SECTION. Quarterly Report. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

From Fallout Program Quarterly Summary Report.

Environmental monitoring of the area surrounding Euratom Ispra Establishment is reported. The amount of ^{90}Sr, ^{89}Sr, ^{137}Cs, ^{238}Pu, and ^{239}Pu was determined in air, water, and milk. The methods used for the determination of ^{90}Sr, ^{137}Cs, gamma-emitting nuclides, and $^{239+240}$Pu are also given. It was concluded that the activity levels shown represented weapons test fallout, and do not reflect any contamination from the site. (D.H.M.)

44124 (NP-18349) STUDY OF THE ATMOSPHERIC DIFFUSION BY A GASEOUS RADIOACTIVE TRACER. Rouzaud, Bertrand (Toulouse Univ. (France). Faculte des Sciences). 1970. 87p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The diffusion of ^{220}Rn from a point source of ^{228}Th (120 mCi) was studied. The device for the measurement of ^{220}Rn is described and the results given. A numerical model is used for the resolution of the diffusion equation. (auth) (France)

44125 (NP-18379) SIXTH ACTIVITY REPORT OF THE RADIOACTIVE FALLOUT LABORATORY, AUGUST 1968–AUGUST 1969. (Atomic Energy Commission, Ankara (Turkey)). 1970. 17p. (In Turkish and English). Dep. CFSTI (U. S. Sales Only).

The results of fallout measurements made at Ankara, Turkey during Aug. 1968 to Sept. 1969, are presented. Included are data on gross beta activity in ground-level air, ^{90}Sr activities in rain and snow, and ^{90}Sr activities in milk. (L.C.L.)

44126 (RT/PROT-(69)13) IMPORTANCE OF THE CROSSWIND INTEGRATED CONCENTRATION IN THE PROBLEM OF ATMOSPHERIC CONTAMINATION AND CHOICE OF THE SITE WHEN ASSOCIATED WITH A MATRIX (CLIMATOLOGICAL) DEFINED OPPORTUNELY. Benfenati, I.; Amadesi, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 28 Feb 1969. 242p. (In Italian). (PRV-r-(68)28). Dep. CFSTI (U. S. Sales Only).

The importance of the Crosswind Integrated Concentration (C.I.C.) in the evaluation, with the help of the local climatology, the micrometeorological characteristics of a site, i.e., the capacity of the local atmosphere to disperse the substance studied—is recognized. Curves and relative methods of calculation of the C.I.C. in the most general case of the fallout of the substance studied are given. The case of zero fallout rate, which is of interest in the release of rare gases (radioactive Kr and Xe) by a nuclear plant and for which the mathematical expressions of the C.I.C. were determined by Meade and Pasquill, was also included. The graphs presented are based on the six Pasquill meteorological categories and on all realistic combinations of the parameters appearing in the expressions of the C.I.C., such as height of release, mean wind velocity, and fallout rate of the waste. The values of the C.I.C. calculated with two equivalent expressions and obtained independently are compared. The first expression was an extension of the Meade and Pasquill formula to the case of non-zero fallout rate and the other was obtained by integration, in the direction transverse to the wind, of the Chamberlain expression deduced originally by the continuous point source. From an examination of the graphs it is established that the two formulas furnish results which are in good agreement for small and medium distances, but diverge significantly at great distances, which illustrates the inadequacy of the Chamberlain expression in this last case. (tr-auth)

44127 (SWRHL-105-r) PROJECT GASBUGGY, OFF-SITE RADIOLOGICAL SAFETY REPORT. GB-2R PHASE I PROGRAM. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jul 1970. 20p. (PNE-G-65). Dep. CFSTI.

Off-site radiological surveillance was provided for the Gasbuggy-2 Redrill (GB-2R)-Phase I program. This surveillance was the continuation of the previous off-site surveillance program for Gasbuggy, and consisted of: operating a daily air sampling network; placing thermoluminescent dosimeters in a network around the site; monitoring for radioactivity; taking special air samples during flaring operations; and collecting water, vegetation, and soil samples after completion of testing operations. The only radioactivity above background levels detected off-site was in special air samples. These samples contained tritium concentrations above background; the concentrations found presented no hazard to any people or livestock living in the off-site area. (auth)

44128 GLOBAL'NOE RASPREDELENIE RADIOAKTIVNOGO STRONTSIYA PO ZEMNOI POVERKHNOSTI (Global Distribution of Radioactive Strontium over the Earth Surface). Pavlotskaya, F. I.; Tyuryukanova, E. B.; Baranov, V. I. Moscow; Izdatel'stvo Nauka (1970). 160p.

The book consists of three chapters. The first chapter covers the variations in Sr fallout in the atmosphere. The second chapter deals with the laws of strontium distribution over the earth's surface. The third chapter covers the peculiarities of strontium concentration in certain soils and landscapes of various soil-climatic regions in the Soviet Union. Extensive references are included. (R.V.J.)

44129 RADIOACTIVE NUCLEAR BOMB FALLOUT: A RELATIONSHIP BETWEEN DEPOSITION, AIR CONCENTRATION, AND RAINFALL. Bradley, W. E. (Illinois State Water Survey, Urbana). Atmos. Environ.; 4: 321-3(May 1970).

Reference is made to van der Westhuizen who formulated some relationships between the radioactivity concentration in air, in precipitation and in total deposition. The assumption is made that the dry fallout in the collector represented a negligible part of the total deposition. This assumption is considered questionable, and is discussed. A reply by van der Westhuizen is given. (UK)

44130 SOME PROBLEMS OF CONCENTRATION MEASUREMENTS OF RADIOACTIVE AEROSOLS IN THE ENVIRONMENTS OF NUCLEAR WORKS. Paulicka, Ivan; Pandula, Stefan; Vodrazkova, Milena (Nuclear Power Station, Bohunice, Czech.). Jad. Energ.; 16: 189-93(Jul 1970). (In Czech).

The need for radioactive aerosol concentration measurements in the environments of nuclear plants before the start of the operation is emphasized. Thus, data on background value and character changes caused by natural aerosols may be obtained. Measurements using a type VS-T-81 instrument are described. Some characteristic results showing expressive fluctuations of natural aerosol concentration level are referred to and analyzed. On the basis of several months' results, the signal height of 9.10^{-14} Ci/l has been proposed and reasons for using this value in nuclear power stations are given. A proposal for deriving the signal level from the difference of absolute data of two instruments located at the opposite sides of a nuclear plant is described. (auth)

44131 ^{90}Sr CONCENTRATIONS IN SURFACE AIR: NORTH AMERICA VERSUS ATLANTIC OCEAN FROM 1966 TO 1969. Freudenthal, Peter C. (Atomic Energy Commission, New York). J. Geophys. Res.; 75: 4089-96(20 Jul 1970).

Strontium-90 in surface air was measured continually for three years, February 1966 to January 1969, at four North Atlantic Ocean weather stations to compare fallout processes over the ocean with those over land. Between 35°N and 55°N, concentrations over land were an average 1.1 times greater than those over the ocean. The relative concentration varied with both season and latitude, being greater in the north and during the summer. This variation seems to correlate better with monsoonal meteorological processes than with the suggested process of aerosol scavenging by ocean spray. (auth)

44132 TRITIUM RAINOUT IN THE UNITED STATES DURING 1966, 1967, AND 1968. Stewart, G. L. (Univ. of Massachusetts, Amherst); Wyerman, T. A. Water Resour. Res.; 6: 77-87(Feb 1970).

Annual weighted average tritium concentration and total tritium rainout for United States precipitation continued to decline during 1966, 1967, and 1968. Arithmetic mean weighted average tritium concentration for 12 network stations decreased about 38% in 1966 compared to 1965; about 35% in 1967 compared to 1966; and about 30% in 1968 compared to 1967. The 1966, 1967, and 1968 values were only 20%, 13%, and 9% respectively, as great as they were in 1963. Tritium data for special samples collected following the Chinese nuclear bomb test on May 9, 1966, and June 17, 1967, indicated that no measurable tritium was added to United States precipitation as a result of these nuclear explosions. Tritium data are presented in both tabular form and on contoured United States maps in order that estimates of the tritium input function from precipitation to hydrologic systems can easily be made. (auth)

44133 INFLUX OF FRESH NUCLEAR FISSION PRODUCTS FROM CHINA BEGINNING JANUARY 1969. Reiter, Reinhold; Sladkovic, Rudolf (Fraunhofer-Gesellschaft, Garmisch-Partenkerchen, Ger.). Meteorol. Rundsch.; 23: 45-7(1970). (In German).

The fallout pattern caused within the alpine area by the Dec. 1968 Chinese nuclear explosion was studied. Measurements of the vertical motion of radioactive aerosols between altitudes of 740 to 3000 m demonstrated the influence of powerful tropospheric downdrafts on fallout distribution of the earth surface as well as the importance of high mountain areas for the early detection of radioactive contamination in the lower troposphere. (H.B.G.)

Mineralogy and Exploration

Refer also to abstracts 44108 and 44159.

44134 CHEMICAL CHARACTERISTICS OF RIVER WATER IN THE EASTERN PART OF SHIMANE PREFECTURE. WITH SPECIAL EMPHASIS ON CAUSE OF URANIUM ANOMALY. Ishihara, Shunso; Mochizuki, Tsunekazu (Geological Survey of Japan, Kawasaki). Chishitsu Chosasho Geppo; 20: 435-48(Jul 1969). (In Japanese).

River water of tributaries of Hii-gawa and Iinashi-gawa in the eastern part of Shimane prefecture was analyzed for P, SO_4^{2-}, and U on 127 samples. The surveyed area is composed mainly of early tertiary granitic rocks, and Miocene andesite and its pyroclastic rocks at north. The Miocene rocks occasionally accompany nonmarine sediments in which a bedded-type uranium deposit can be locally located, as shown as an example near Mitoya. This work was done essentially for geochemical prospecting of the area. Distinct uranium anomalies found in a reconnaissance study were also examined in detail. During the period of this study around the end of August in 1967, there was no accidental condition e.g., heavy rainfall, that would affect the chemical character of the water. A weak anomaly, 0.18 ppb U, was detected near an edge of the Miocene rocks. Distinct anomalies of uranium along the Ayo river are due to mining operations of uraniferous and pyrite-bearing molybdenite quartz vein deposits, which are the largest source of molybdenum production in Japan. The uranium decreases downward with a rate of 0.07 ppb/km along the Ayo river. Except the mining area, the water of granite region is about neutral (pH = 7.0), higher in U and lower in SO_4^{2-} in comparison with that of andesite region. (auth) (Japan)

44135 GEOKHIMIYA I MINERALOGIYA RADIOAKTIVNYKH ELEMENTOV SIBIRI. (Geochemistry and Mineralogy of Radioactive Elements in Siberia). Mitropol'skii, A. S. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). 164p.

The first three articles of the book deal with the problems of uranium deposits occurrence and genesis, conditions of uranium concentration by natural sorbents during the lythogenesis process, morphological properties of uranium, paragenesis of vein formation and uranium mineralization, and the hypothesis of red coloring as a result of iron and hydroxides of iron depositions. Data are given for U and Th contents in alkali magnetic rock of various ages from Kuznets Oltau, and radiometric determinations of K, U, and Th in eroded oxidized igneous and metamorphic rock of Enisei plateau. Various types of ancient radioactive conglomerates are covered in the last three chapters. 12 references. (R.V.J.)

44136 URANIUM IN CARBONACEOUS DEPOSITS. Ostrovskaya, G. Ya. At. Energ. (USSR); 28: 467-71(Jun 1970). (In Russian).

It has been repeatedly noted that the uranium content is low in anthracite and highly-metamorphized coals, while it is high in weakly-metamorphized coals, brown coal, lignite and peat. A high uranium content is related to the ash content of a coal. The main mass of uranium is adsorbed by the organic matter of coal, and uranium minerals are encountered only in the weathered portions of the coal deposit. Ten types of carbonaceous formation have been distinguished, and these ten types can be reduced to five groups. The first three groups comprise about 50% of the coal deposits, and are not suitable for uranium prospecting. The brown coals at the boundaries of old stable platform regions having a uranium content of 0.01 to 0.001 percent uranium represent the greatest reserves of uranium for exploitation (2300 million tons of uranium in the U.S.A.). These coals have a high humic acid content. (TTT)

44137 NUCLEAR RAW MATERIALS. Cameron, J. (International Atomic Energy Agency, Vienna). pp 153-68 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

It is clear that in the next decades there will be a substantial and increasing demand for uranium to fuel nuclear power stations. In a developing country, the discovery and development of uranium resources can be of importance either for the development of national nuclear power or for the commercial export of uranium. As the time taken between the start of a uranium exploration program and the uranium production stage may be of the order of 6 to 10 years, it is now opportune to start new exploration so that advantage of the increased demand in the mid-1970s may be achieved. Thorium will also be of interest, but in the more distant future when the thorium cycle for advanced converters and breeder reactors is fully developed. (auth)

44138 EXPLORATION FOR RADIOACTIVE OCCURRENCES IN EGYPT, U. A. R. El-Shazly, E. M.; Hussein, H. A.; Meshref, W. M.; Assaf, H. S. (Atomic Energy Establishment, Cairo). pp 179-84 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Exploration for radioactive occurrences in Egypt has been carried out essentially by the use of radiometric methods and the application of geological criteria. These surface methods which are not particularly expensive have been particularly useful since rock exposures are common. However, through the advancement of exploration work, geophysical methods other than radiometric are becoming important to follow the radioactive occurrences in depth. Aerial radiometry is normally carried out at a nominal height of 50 m and in parallel lines spaced 250 to 1000 m approximately perpendicular to major structures of the surveyed area. Due to considerable variations in background radioactivity, statistical analysis of the radiometric data has been carried out to evaluate in a better manner anomalies encountered in different rock types. Carborne and foot prospecting are used to prove the anomalies found by aerial surveying and to fill in the gaps in the

latter. Carborne radiometry is more useful in topographically gentle areas where rock exposures are easily passable by cars. Geological criteria used in the exploration of radioactive occurrences include structural, lithological, stratigraphical and alteration phenomena. The application of one or more of the previous criteria depends on the geological factors controlling the deposition and accumulation of each particular type of radioactive occurrence. Means of African inter-State cooperation in this field are suggested. (auth)

44139 PROSPECTION, EXPLOITATION, AND DEVELOPMENT OF RADIOACTIVE ORE DEPOSITS IN THE DEMOCRATIC REPUBLIC OF THE CONGO. Malu, F. (Centre Nucleaire TRICO, Kinshasa, Congo). pp 185-91 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The methods used by the ex-Union Miniere du Haut-Katanga in the prospection, exploitation and development of radioactive ore deposits are reviewed. A discussion of the possibility of resuming the production of uranium and three projects under study is presented. (auth)

44140 URANIUM PROSPECTING IN KATANGA. Oosterbosch, R. (GECOMIN, Lubumbashi, Congo). pp 193-4 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Methods for uranium prospecting in the Katanga region of the Congo Republic are discussed. (R.C.K.)

44141 URANIUM PROSPECTING AND EXPLOITATION IN GABON. Ampamba-Gouerangue, P. (Ministere des Mines, de l'Energie et des Ressources Hydrauliques, Libreville, Gabon). pp 221-3 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The principal stages in uranium prospecting in Gabon are discussed, and the methods, results and future prospects are reviewed. (auth)

44142 SOME PECULIARITIES OF URANIUM RESERVE ESTIMATION FOR UNDERGROUND LEACHING IN SEDIMENTARY ROCKS. Novik-Kachan, V. P. At. Energ. (USSR); 29: 3-6(Jul 1970). (In Russian).

A new method of uranium reserve estimation for underground leaching in permeable sedimentary rocks is discussed. The possibility of lowering of cut-off grade of metal is mentioned. The evidence is given for estimating the reserves of metal in a productive stratum without the estimation of ore reserves. As the ore processing occurs underground (in situ), the method of metal reserve estimation in the productive solution is given. (auth)

44143 FRENCH URANIUM. Grenon, Michel. Sci. Progr. Decouverte; No. 3424, 25-34(Aug 1970). (In French).

Some aspects of the uranium world market are reviewed, and the uranium resources of France are discussed. (L.C.L.)

44144 INTERPRETING γ-MEASUREMENTS OF AN EXOGENOUS EPIGENETIC URANIUM DEPOSIT. Pritchin, B. P. This paper was summarized in At. Energ. (USSR); 26: 456-7(May 1969) as paper No. 299. (In Russian).

Regular changes in the radioactive-element content were found in a study of deposits connected with stratified oxidation zones. Methods for interpreting the data from γ-cores and γ-assays were developed on the basis of these changes. The distribution of uranium and radium contents over a transverse cross-section of the "wings"—deposit regions separated by an oxidation zone—was constructed by statistical generalization. The generalized radium distributions for various wing thicknesses were used as initial data from which methods for finding the ore boundaries were determined, after calculation of the theoretical γ-intensity. The boundary on the oxidation-zone side corresponds to the point where the γ-intensity is 0.75 the maximum; at the opposite boundary, the ratio I_{bdry}/I_{max} varies from 0.3 to 0.7, inversely proportional to the wing thickness. The ore boundary on the unoxidized-rock side can be found in terms of this intensity. This method is applicable for all deposits, not only for wings. It is convenient because the ore is practically uniform in all the layers in the zone bounding the unoxidized rock, i.e., the value of this intensity is the same in all layers. An area-ratio method is proposed for determining the uranium content. The areas are computed from the theoretical γ-intensity curves, and the area ratio is given as a function of the ore strength. A correction must be applied to the results of the uranium content determination to account for the disruption of the radioactive equilibrium. This correction is expressed as a K_{re} averaged over the ore intersection (K_{re} is the radioactive equilibrium constant between uranium and radium). The quantity K_{re} is evaluated from geological assay data. In beds below the stratified oxidation zone (in "pockets"), K_{re} varies randomly; accordingly, one value of K_{re} (an average over the whole pocket) may be used to correct all the data points. The accuracy of the correction depends on the number of points in the reference assay. A dependence of K_{re} on the thickness is typical for deposit wings, and therefore the dispersion in K_{re} is considerably larger than in pockets, especially if the wing thickness varies over a wide range. One value of K_{re} should be used for all the assay points because of the large dispersion. Use of the generalized thickness dependence of K_{re} increases the accuracy of the account of K_{re} in wing regions not studied. A test of these methods showed that the accuracy in the determination of the ore boundary position and the uranium content approaches that of γ-coring and γ-assay results at sites with simple radiological conditions. (auth)

Oceanography

Refer also to abstracts 44095 and 44121.

44145 (HASL-217, pp I.9-118) SOME CONCENTRATIONS OF ^{137}Cs AT MODERATE DEPTHS IN THE PACIFIC, 1965-1968. Folsom, T. R.; Sreekumaran, C.; Hansen, N.; Moore, J. M.; Grismore, R. (Scripps Institution of Oceanography, La Jolla, Calif.).

From Fallout Program Quarterly Summary Report.

Subsurface concentrations of fallout ^{137}Cs measured at 44 Pacific stations between 1965 and 1968 are reported in graphs and tables. The measurements were made with procedures designed specifically for investigating detailed variations of the concentrations of ^{137}Cs in waters above about 500 meters, but over wide reaches of the Pacific using ships of opportunity. The techniques are described briefly. It should be noted that they were not designed for precise measurements in truly deep water. In most cases salinity and temperature data were collected with the ^{137}Cs samples, and some ^{133}Cs samples also were collected for standardizing the water volumes from which ^{137}Cs was sampled. The presence of salinity minima at depths where the ^{137}Cs concentration was maximum suggests regions of entry of fallout in the far north, and subsequent movement in unmixed layers for many thousands of miles during several years. Relatively large amounts of fallout were observed to penetrate below 500 meters near Japan, whereas high concentrations (much higher than those below or above) were observed in thin strata above 200 meters in the oceanic region south and east of Hawaii. (auth)

44146 (HASL-217, pp I.119-29) CAN LAND RUN-OFF BE A MAJOR VECTOR OF FALLOUT TO THE OCEANS. Bowen, Vaughan T.; Noshkin, Victor E. (Woods Hole Oceanographic Institution, Mass.); Volchok, Herbert L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program Quarterly Summary Report.

It was concluded from examination of the available data from several ocean areas especially favorable for the observation of a significant land run-off contribution of fallout radionuclides, and specifically of ^{90}Sr, that there is no evidence that this is a major contribution. This is in agreement with the prediction from consideration of the land:water area ratios, of river water ^{90}Sr concentrations, or of the soil data as evidence of possible ^{90}Sr loss from the land. (auth)

44147 (TID-25493) OCEANIC CONCENTRATIONS OF ^{228}Ra AND A MODEL FOR ITS SUPPLY. Moore, Willard S. (State Univ. of New York, Stony Brook). May 1969. 25p. Dep. CFSTI.

Thesis.

The worldwide oceanic distribution of ^{228}Ra is evaluated. Nearshore waters, especially waters from restricted bays and sounds, are very high in unsupported ^{228}Ra. The concentrations decrease away from land. The ^{228}Ra content of surface waters bears a close correlation with the proximity to land. Samples from the Atlantic Ocean are higher than those from the Pacific Ocean. Apparently the source of ^{228}Ra in surface waters is diffusion from ^{232}Th-bearing sediments in contact with these waters. Deep water samples collected <100 meters from the sea floor have significant ^{228}Ra concentrations. Apparently ^{228}Ra is diffusing from deep-sea sediments as it is from nearshore sediments. Deep Pacific samples are generally lower than deep Atlantic samples. This may mean that ^{228}Ra released from Pacific sediments is mixed upward more rapidly, thereby decreasing the near-bottom concentrations. Intermediate water samples have less ^{228}Ra than either surface or bottom samples from the same area.

These concentrations are near the lower limit of detection. Because the vertical mixing rate of the ocean is much greater than the mean life of ^{228}Ra, little ^{228}Ra can penetrate into the intermediate ocean. (auth)

44148 DISTRIBUTION OF LONG-LIVED RADIONUCLIDES AND WATER CIRCULATION IN THE TROPICAL ZONE OF THE ATLANTIC OCEAN. Khanaichenko, N. K. Okeanologiya; 10: 264-75(Mar-Apr 1970). (In Russian).

Large amounts of radioactive products, including long-lived radionuclides, have been introduced from the atmosphere into the ocean as a result of nuclear weapon tests. Consideration is being given to: the possibility of applying the distribution of long-lived radionuclides (as the most stable characteristics) in the ocean to the analysis of water dynamics, and the causes responsible for the nonuniform distribution of radionuclides both at the ocean surface and in depths. The rate of ^{90}Sr concentration in the tropical zone of the Atlantic Ocean in 1963 to 1964 was determined. Based upon these rates and the present-day knowledge of the nature of water circulation, an explanation is given of the nonuniform distribution of ^{90}Sr concentration at the ocean surface. Almost uncontaminated deep waters are found to ascend in the regions off the northwestern coast of Africa and along the Brazil Current periphery. The occurrence of high ^{90}Sr concentrations in the deep ocean layers is shown to be caused mainly by the advective transport from the ocean surface into depths. (auth)

Seismology

44149 (HN-20-1039) STRUCTURAL RESPONSE TO CLOSE-IN HORIZONTAL GROUND MOTION FROM UNDERGROUND NUCLEAR TESTS AT PAHUTE MESA. Stevenson, H. F. (Holmes and Narver, Inc., Las Vegas, Nev. On-Continent Test Div.). May 1970. 170p. Dep. CFSTI.

The rational design of close-in structures and the assessment of the vulnerability of facilities to close-in ground motions require the formulation of techniques for predicting the ground motion parameters needed to perform meaningful structural response analyses. The response of a single degree of freedom elastic structure to the horizontal components of ground motion from three events recorded at eight stations as well as the horizontal motion recorded at six additional stations is considered. Horizontal motion is considered in the radial direction and in the tangential direction with reference to the recording station. The radial direction may be defined as the direction along the line joining the recording station and the ground surface at the point of detonation. The tangential direction is normal to the radial direction. Information is presented on: the structural response spectra as a function of damping for each of the recorded ground motions; a comparison of the structural response spectra generated from the ground velocity-time history record with those generated from the ground acceleration-time history record for the eight sets of data where the ground velocity and ground acceleration-time history records are both available; and a procedure which permits the generation of structural response spectra envelopes when given certain peak parameter information concerning the horizontal ground motion. Structure frequencies ranging from 0.2 cycles per second (cps) through 20 cps are considered. It was found that the influence of structural damping on response at and near surface zero is significant, therefore, damping must be considered in the design of close-in structures; peak response can be reasonably predicted when given predicted values for the peak parameters of horizontal motion components; and simple ground motion-time history pulse shapes could not be readily formulated from predicted peak parameters such that response spectra would be produced that correlated well with response spectra generated from the actual ground motion record over the entire range of frequencies and slant ranges considered in this study. (R.C.K.)

44150 (NVO-1163-203) SEISMIC RESPONSE CHARACTERISTICS AT LAS VEGAS, NEVADA, FROM UNDERGROUND NUCLEAR DETONATIONS. Davis, L. L.; Lynch, R. D. (Environmental Research Corp., Alexandria, Va.). Jun 1970. Contract AT(29-2)-1163. 100p. Dep. CFSTI.

The seismic response of the Las Vegas area is described in terms of the level of motion as defined by the peak amplitudes of the ground motions and the frequency content of the motion as defined by Pseudo-Relative Velocity Response (PSRV) spectra. The seismic response of specific stations, the variation in response from station to station, and the overall response in the city are discussed. Several methods were used to examine the seismic response characteristics. At stations where sufficient data were available, statistical regression equations expressing amplitude as a function of yield were fitted to the peak amplitude and PSRV data. Equations were developed for two stations, SE-6 and Squires Park, and for a total sample using all Las Vegas data. Data samples were subgrouped according to the location of the detonation (Pahute Mesa or Yucca Flat) in order to minimize variations caused by differences in distance. Another approach was to select a standard station (SE-6) and to calculate ratios of the data, other stations to SE-6, for each detonation. This ratio was independent of source parameters and defined, with the exception of minor transmission path differences, the local station response characteristics relative to SE-6. Ratios were calculated for the peak amplitudes and for the PSRV amplitudes at each of forty periods between 0.50 and 2.469 seconds. The geometric averages of these ratios indicated systematic differences at some stations. A third approach utilized the statistical technique of covariance regression analysis in which station data were combined to determine a simple yield scaling exponent for the total sample. The analysis provides individual station amplitude factors from which relative amplitudes between stations can be determined. (auth)

44151 (UCRL-50896) MATHEMATICAL APPROACH TO THE INFLUENCE OF GEOLOGICAL FORMATIONS ON SEISMIC MOTIONS. Frazier, Gerald A.; Roberts, John E. (California Univ., Livermore. Lawrence Radiation Lab.). Jun 1970. 36p. Dep. CFSTI.

We developed a mathematical approach for analyzing the influence of geological formations on seismic motions. The time-dependent behavior of the geological formations was obtained by a modal analysis in which the complexities of the formations can be treated on a time-independent basis. The amplification of sinusoidal motions by a single-layered alluvial plain was calculated as a simple illustrative example. (auth)

44152 (USGS-474-76) SEISMIC REFRACTION SURVEY AT THE UNa SITE, NEVADA TEST SITE, NYE COUNTY, NEVADA. Hazlewood, R. M. (Geological Survey, Denver, Colo.). 1970. Contract AT(29-2)-474. 10p. (NTS-226). Dep. CFSTI.

A seismic refraction survey was made at the UNa site, Nevada Test Site. The results of the survey were successful in determining velocities and the depth to bedrock. There is a near-surface velocity of 3,000 feet per second and intermediate velocity of 5,500 feet per second. Bedrock velocity is 11,000 feet per second with depths ranging from 170 to 219 feet. (auth)

44153 THE PP WAVE GENERATED IN ATOMIC EXPLOSIONS AND ATTENUATION OF LONGITUDINAL WAVES IN THE UPPER MANTLE. Vinnik, L. P.; Dashov, G. G. (Inst. of Terrestrial Physics, Moscow). Dokl. Akad. Nauk SSSR; 190: 1340-3(21 Feb 1970). (In Russian).

The amplitudes of longitudinal seismic P waves, reflected from the surface of the Earth at half-epicentral distance, were analyzed, assuming that the amplitude of a seismic wave taken as a random value is subject to a normal logarithmic distribution. The formulas used to express the parameters were derived on the basis of probability calculations; they were applied to analyze the seismograms generated by underground nuclear explosions recorded on the short-period instruments at Soviet seismic stations. Analysis of the P waves allowed to estimate the absorption of longitudinal waves in the upper mantle of the earth. The values obtained were higher than those reported before. The results do not contradict the previously advanced mechanisms of the absorption of seismic energy, if it is also assumed that within the 1 to 0.003 Hz range, the value of the quality factor Q is practically independent of the frequency. (TTT)

44154 EFFECT OF CRUSTAL STRUCTURE ON RAYLEIGH WAVES GENERATED BY ATMOSPHERIC EXPLOSIONS. Harkrider, David G. (Brown Univ., Providence); Flinn, Edward A. Rev. Geophys. Space Phys.; 8: 501-16(Aug 1970).

Theoretical seismograms are calculated at a teleseismic distance from atmospheric sources over oceanic and continental earth models. Vertical surface displacements of the fundamental and first higher-mode Rayleigh waves are obtained for each of the models. Source altitudes range from 0.3 to 4.88 km for a 1-kiloton nuclear explosion in a stratified thermal atmosphere. At 20-sec period, an explosion over the oceanic model exhibits amplitudes an order of magnitude greater than the equivalent amplitudes from an explosion of the same burst height and yield over any of the three continental structures. If the differences in anelastic attenuation over the paths are included, this effect will be reversed at large enough distances. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 44099, 44117, 44127, 44149–44151, 44153, 44154, 44360, and 45144.

44155 (CEA-R-3983) CIVIL ENGINEERING EARTH WORK AND NUCLEAR EXPLOSIONS. Delort, Francis (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Aug 1970. 54p. (In French). Dep. CFSTI (U. S. Sales Only).

The mechanical effects of nuclear explosions leading to the formation of craters or of trenches are presented from the point of view of a possible industrial application. For canal construction, it is possible to calculate the spacing of the charges so as to use the minimum total energy. In the case of applications at a single point: ports, quarries and dams, energies of a few tens of kilotons, at the most, should be sufficient for work in difficult surroundings. (auth) (France)

44156 (ITR-1816) CRATER STUDIES. Project 1.9/26.2 of OPERATION NOUGAT, PROJECT DANNY BOY. Nordyke, Milo D. (California Univ., Livermore. Lawrence Radiation Lab.). 1 Aug 1962. 30p. Dep. CFSTI.

Preliminary results of Danny Boy crater studies indicate that the crater had a radius of 33 meters and a depth of 19 meters. These values are well within the preshot predictions and confirm that $W^{3.4}$ scaling of basalt data is approximately correct and that nuclear and chemical explosions are approximately equivalent in their cratering effectiveness in basalt. (auth)

44157 PROBLEMS ARISING FROM NUCLEAR BLASTING FOR OIL AND GAS PRODUCTION. Langer, Michael; Caspari, Albrecht; Wuestenhagen, Karl (Deutsche Gesellschaft fuer Mineraloelwissenschaft und Kohlechemie, Stuttgart). Erdoel Kohle, Erdgas, Petrochem.; 23: 275-81(May 1970). (In German).

After a brief introduction into the relevant problems, a description is given of some projects which in the USA are either carried out or envisaged within the framework of the Plowshare program. These projects are, in particular, Bronco, Ketch, Gasbuggy, and Rulison and are centered on the endeavors for reaching a more economical oil and gas exploitation by increasing the permeability of the carrier bed by nuclear explosions. Subsequently, a number of special problems resulting from the application of nuclear explosions for civil engineering purposes, especially those connected with the assessment of damages (radioactivity, shock wave, stability of the loaded rock), are discussed. Future projects for the construction of storage cavities for gas, liquid petroleum, and crude oil, should consider the economics of using nuclear explosives. (auth)

44158 PREVENTING THE SPREAD OF NUCLEAR WEAPONS. Barnaby, C. F. (ed.). Pugwash Monograph I. London; Souvenir Press (1969). 374p. 63s. (CONF-680473).

The Pugwash conferences on science and world affairs are international forums for the discussion of problems relating to world security, particularly those arising from the advance of science and technology. A series of Pugwash Symposia is being organized to study some of these problems in depth. The first of these discussed the implications of the proliferation of nuclear weapons. This monograph contains the papers submitted to the Symposium and a summary of the discussions which took place. The technical aspects of the subject which were discussed included the development of nuclear energy programmes, the civilian uses of nuclear explosives and the prospects for breeder reactors. The question of international safeguards for the future control of atomic energy occupied a prominent part in the Symposium. Among the political aspects of nonproliferation examined were the incentives for acquiring nuclear weapons, methods of furthering the acceptance of a nonproliferation treaty, the objections of the smaller powers to such a treaty, and the policy of reactor exporting countries. (auth) (UK)

44159 STATE OF MINERAL EXTRACTION PROJECTS USING NUCLEAR EXPLOSIVES. Hamburger, Richard (Atomic Energy Commission, Washington, D. C.). Mining Congr. J.: 56: No. 7, 48-52(Jul 1970).

The use of nuclear explosives in mineral extraction processes is discussed with particular reference to the mining of low-grade ores. Costs of conventional and nuclear mining methods and the cost-yield relations for chemical and nuclear explosives are compared. It is concluded that nuclear explosion mining methods are promising and will create new concepts in mineral recovery procedures in the future. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 44184, 44226, 44324, 44342, 44389, 44652. 44686, 45214, and 46098.

44160 (CEA-CONF-1496) FLOODING PHENOMENON IN A CRYOGENIC HEAT PIPE WITH VERTICAL COUNTERCURRENT TWO-PHASE FLOW. Ewald, Rolf; Lacaze, Albert; Perroud, Paul (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1970]. 14p. (In French). (CONF-700522-1). Dep. CFSTI (U. S. Sales Only).

From 3rd International Cryogenic Engineering Conference, West Berlin, Germany.

A vertical tube has been used to study experimentally the behavior of a vaporization-condensation cryogenic heat pipe, by analogy to the well-known heat pipe recently developed for higher temperatures. The flow in the vertical tube connecting the vaporizer to the condenser is countercurrent, the liquid flowing downwards as in annular film at the wall, while the vapor circulates upwards in the center. Experiments have been carried out in a glass apparatus using nitrogen, hydrogen, and deuterium boiling under medium pressures. The thermal power supplied to the boiler cell and the diameter of the vertical tube were varied until flooding occurred. A dimensional analysis permitting a good correlation of experimental results is presented. A comparison of the data with previous correlations established for other fluids at room temperature is also given. (auth)

44161 (CONF-700211-4) CHARACTERISTICS OF BUILT-IN ONCE-THROUGH TYPE STEAM GENERATOR. Oyama, Shinichi; Furukawa, Tetsuro. Translated from Japan Atomic Energy Society Meeting, Tokyo, February 12-13, 1970. 9p. Dep. CFSTI.

Overall heat transfer characteristics, pressure loss characteristics, flow stability, and transitional characteristics of built-in once-through type steam boilers are examined. It is believed that the general characteristics of this type of steam generators have become known except a few aspects of large numbers of parallel tubes. (J.R.D.)

44162 (RHEL/R-197) ESTIMATES FOR THE FIELD ERRORS FROM COIL WINDING IRREGULARITIES IN SUPERCONDUCTING MAGNETS. Randle, T. C. (Rutherford High Energy Lab., Chilton (England)). Jun 1970. 12p. Dep. CFSTI (U. S. Sales Only). UK 1s. 9d.

The magnetic field errors arising from the irregularities in conductor positioning of an air cored magnet are estimated statistically. The effects on the harmonic field coefficients for bending and quadrupole magnets are included. (auth) (UK)

44163 IMPROVEMENTS IN DEVICES FOR PROVIDING SHIELDING FROM RADIOACTIVE RADIATION. Brisac, Michel (to Commissariat a l'Energie Atomique). British Patent 1,201,258. 5 Aug 1970. Priority date 17 May 1968, France.

A rotary device for closure or opening a passageway through a wall is described. The wall may define a sealed enclosure for containing radioactive articles or substances. The rotary device is housed within the wall and incorporates a bore type opening to allow passage through the wall. (J.R.D.)

44164 IMPROVEMENTS IN AND RELATING TO BAND-SAW CUTTING-MACHINES. Gasne, Gaston; LeMetayer, Jean (to Commissariat a l'Energie Atomique). British Patent 1,202,172. 12 Aug 1970. Priority date 22 Mar 1968, France.

A band-saw cutting machine is described comprising a flexible endless band which is rectilinearly movable for cutting metallic materials. The workpiece to be cut is supported in place on a table and enclosed in a box to recover fumes generated in the cutting. The box design includes a slit for the saw and a method of maintaining negative pressure. The machine is equipped with water boxes for saw decontamination; it is also equipped with spark deflectors. (J.R.D.)

44165 ION SOURCES USABLE FOR SPACE PROPULSION. Le Grives, Emile (ONERA, Chatillon-sous-Bagneux, France). pp 471-95 of Premiere Conference Internationale sur les Sources

d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

These sources must meet special requirements. The problems involved are formulated in terms of a set of conditions common to the various types of electrostatic propellers. The special cases of cesium/tungsten contact ionization sources and of electron bombardment ionization sources are investigated. A few examples of the recent models built for active corrections of geo-steady satellites or for interorbital transfer services are given for an evaluation of the expected development of ionic propulsion. (France)

44166 CLEANING OF PIPING FOR NUCLEAR SYSTEMS. Stock, H. J. (General Electric Co., San Jose, Calif.). Heat., Piping Air Cond.; 42: 110–14(Apr 1970).

Requirements for cleaning the internal surfaces of pipes in nuclear systems are discussed. Methods for removing loose particulate matter, organic deposits, and water soluble materials from these surfaces are outlined. The types of damage which may result from the use of some cleaning agents with specific piping materials are presented. Points to be considered in writing cleaning procedure specifications, in protecting piping cleanliness during shipment and storage, and in evaluating the cleanliness of an assembled piping system are included. (L.C.L.)

44167 METHOD AND APPARATUS FOR MEASURING THE POROSITY OF MATERIALS AND STRUCTURES. Thorpe, James Albert; Preston, George Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,197,631. 8 Jul 1970. Filed 2 May 1967.

It is stated that there is an increasing need for means of measuring the porosity of constructional materials and the leak tightness of joints formed by edge abutment of adjoining members of a building structure. For example, in designing a concrete reactor pressure vessel it is desirable to know the approximate rate of leakage of fluid at the working pressure of the vessel through unit concrete area, and in designing a building structure comprising wall modules sealably joined at their edges to form a building capable of containing a low vacuum, it is desirable to know the leakage through unit length of the joint. For the former requirement complex instruments making use of ultrasonics have been employed, but for the latter no suitable instrument is known. The object of the system described is to provide a cheap method which is simple to use and capable of giving data of sufficient accuracy to assist in design. The method creating an evacuated chamber defined in part by the sample surface area and creating a second evacuated chamber defined in part by a surface area adjoining the sample surface area, the first and second chambers having a common boundary which bounds a major part of the first chamber. The vacuums within the chambers are balanced and the fluid flow from the first chamber to the vacuum source is measured, giving a measure of the porosity or leak tightness of the sample surface area. The degree of accuracy is dependent on the extent to which the second chamber bounds the first chamber for which reason it is preferable that the common boundary surrounds the sample surface area. The required apparatus comprises a suction head sealingly engaging a surface to define first and second evacuable chambers having a common boundary which bounds a major part of the first chamber, vacuum plant connectable to the evacuable chambers, and means for balancing the vacuum in the chambers, together with means for measuring fluid flow from the first chamber to the vacuum plant. The common boundary preferably surrounds the first evacuable chamber. (UK)

44168 VIBRATION OF CONTAINING STRUCTURES BY SOUND IN THE CONTAINED FLUID. Fahy, F. J. J. Sound Vib.; 10: 490–512(Nov 1969).

The gas circulators of CO_2-cooled nuclear reactors can produce 10^3 to 10^4 W of acoustic power. A rigid reactangular box with one simply-supported flexible wall was analyzed numerically and statistically for the internal acousto-structural mode coupling factors and the modal average radiation efficiency. (Fuel Abst.)

44169 IMPROVEMENTS IN OR RELATING TO ELECTRON IRRADIATION APPARATUS. McCann, John David (to United Kingdom Atomic Energy Authority). British Patent 1,199,282. 22 Jul 1970. Filed 8 Aug 1966.

Reference is made to apparatus particularly but not exclusively concerned with the irradiation of irregular shaped objects, for example for the surface treatment of materials. The apparatus described is for application of a protective film, and comprises an electrostatic spraying region and an electron irradiation curing region. A conveyor system is provided, together with means for applying different potentials to the objects on the conveyor at different points within the apparatus. The curing region comprises an elongated emitter cathode, together with an electron focusing assembly maintained at substantially the same potential as the emitter cathode. The latter may be mounted in the focusing assembly and the anode for the electron gun may be formed with a rectangular slit dimensional so that an elongated electron beam from the emitter cathode just passes through the slit. A window is provided in the evacuated chamber for emergence of the electron beam. A high voltage DC electrical supply provides a constant accelerating voltage between the emitter cathode and the anode. A number of electron emitting elements may be provided, each with a focusing assembly, to give convergent electron beams. The means for supplying different potentials to the objects may be a pick-up rail connected to the object through a sliding contact on each carriage of the conveyor system. The outer ends of the rail may be grounded and a high potential supply connected to a point along the length of the rail, which may be arranged so that its inner portion is of low electrical resistance and the outer portions of high resistance. (UK)

44170 COMPUTATIONS RELATIVE TO VESSELS USED IN NUCLEAR INSTALLATIONS. PART Ia. THE GENERAL PROBLEM. Surace, Giuseppe (Politecnico, Turin). Termotecnica (Milan); 24: 224–8(May 1970). (In Italian).

The second order approach to the differential set of simultaneous equations relative to the three possible used in connection and expansion joints, in axisymmetric applications subject to pressure, axial load, and a thermal transient situation is presented. It is shown how the three sets of simultaneous equations can be recollected into a four unknowns set of four simultaneous equations, a matrix form for the finite differentials solution is found which allows one to evaluate, at the same time, the stress and deformation characteristics inside the considered structure. (auth)

44171 COMPUTATIONS RELATIVE TO VESSELS USED IN NUCLEAR INSTALLATIONS. PART IIa. THE INFLUENCE OF PRESSURE AND AXIAL LOAD. Surace, Giuseppe (Istituto di Costruzioni Aeronautiche, Turin). Termotecnica (Milan); 24: 271–81(Jun 1970). (In Italian).

The flexibility matrix relative to a toroidal union with a constant meridian curvature and to an ellipsoidal union; and the influence of pressure on radial deformation and rotation of boundaries are discussed, and the so-called interior coefficients determined. Finally, the influence of axial load on a generic shell is examined and the formulae relative to a toroidal union are given. (auth)

44172 APPARATUS FOR THE STUDY OF ELECTRICAL DISCHARGES AT PRESSURES OF 10^{-10} TORR AND VOLTAGES UP TO 250kV. Kelsey, T.; Tedford, D. J. (Univ. of Strathclyde, Scotland). Vacuum; 20: 291–2(Jul 1970).

An apparatus is described which provides clean, high vacuum conditions (10^{-10} torr) for the study of electrical discharges at up to 250kV dc. The vessel and experimental electrodes are bakeable to 400°C. (auth)

44173 CESIUM 2000 Ci IRRADIATION FACILITY FOR CALIBRATION PURPOSES. Fessler, H.; Piesch, E. (Kernforschungzentrum, Karlsruhe, Ger.). Kerntechnik; 12: 298–302(Jul 1970). (In German and English).

Use of an irradiation facility with a beam cone directed vertically upwards for calibrating radiation protection dosimeters is described. The facility is equipped with three ^{137}Cs sources making it possible to achieve exposure rates ranging from 0.1 to 4000 R/hr. The design of this facility is described along with the safety devices required and the exposure rates measured in the course of commissioning. (auth)

44174 UF_6 SAMPLING AND SHIPPING FACILITY (27 May 1969)(Engineering Materials). (Goodyear Atomic Corp., Piketon, Ohio). (CAPE–2021).

48 drawings.

A facility for sampling uranium hexafluoride at assays exceeding 5 wt % ^{235}U is described in this package of drawings. Equipment is available for liquefying and sampling material from 5, 8, and 12 in. shipping cylinders as well as from 2.5 ton cylinders. Tumblers, used to homogenize UF_6 prior to sampling as well as for tipping the cylinder for connection to the sampling manifolds where the UF_6 is withdrawn into calibrated sampling blocks, are in the form of specialized dollies. The sampling manifolds are supplemented by ventilation systems and evacuation trapping systems. The ventilation system minimizes airborne contamination in the event of UF_6 release, and the evacuation trapping systems facilitate the purging of pigtails and sample lines. Precision weighing

of both full and empty cylinders is effected at ±1.1 gram. (For details see TID-4100 Suppl. 61) (See also 23: 43433) (F.S.)

44175 GASKETS FOR A NUCLEAR HIGH-TEMPERATURE, HIGH-PRESSURE GAS LOOP. Toma, Hiromichi (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Haikan To Sochi; 10: No. 2, 18-23(Feb 1970). (In Japanese).

The gaskets used for a high-temperature, high-pressure gas loop, in association with the test of fuel for a nuclear reactor, are varied, and each gasket with its own features works effectively in the right place. The employment of particular gaskets depends largely on the corresponding flanges where they are applied. In this connection, the flange-structure with a self energized gasket is particularly useful when the deformation of piping is significant because of the cyclic change of pressure and temperature. In this case, the tightening force is not reduced by internal pressure. First, the outline of the high-temperature, high-pressure loop, and then, forced-fastening type gaskets are described. Finally, the following items of the self energized gasket are discussed: leakage, sealing criteria, including the effect of the finishing of sealing surfaces, and the initial load and the residual load on the sealing surfaces. (Japan)

44176 IMPROVEMENTS IN OR RELATING TO IRRADIATION MACHINES. McCann, John David (to United Kingdom Atomic Energy Authority). British Patent 1,199,571. 22 Jul 1970. Filed 8 Aug 1966.

A commercial electron-irradiation machine that has a potential of 250 to 500 kV, that is cheap to operate and maintain, and that contains a minimum of high voltage components is described. The machine comprises a vacuum enclosure having an electrically conducting stem, an electron emitting cathode connected to this stem, an apertured anode spaced from the emitter cathode, and a further electrode, which forms the cathode of a rectifying diode arranged around the stem; the stem also forms an anode for the rectifying diode. Two or more acceleration stages may be employed using accelerating anodes, which are maintained at increasingly positive potentials and are connected to transformer taps. A rectifying diode is provided for each of these anodes, the anode of each diode being formed by the respective accelerating anode and the cathode by an electrode located in the vacuum enclosure. (UK)

44177 METHOD OF CENTRIFUGAL SEPARATION AND RECOVERY OF CHEMICAL SPECIES UTILIZING A LIQUID MEDIUM. Anderson, Norman G. (to United States Atomic Energy Commission). U. S. Patent 3,519,400. 7 Jul 1970. Filed 25 Jan 1967.

A method for separating chemical species from a mixture by centrifugation of the mixture through a liquid density gradient containing chemical reagents arranged in zones within the density gradient to provide a predetermined sequence of chemical treatments is described. The method is based upon the principle that particulate material is caused to sediment in a centrifugal field, while molecular size material in solution is relatively unaffected. Thus, chemically active reagents immobilized in a density gradient can be arranged to provide a preselected sequence of steps in a separation process involving particulate matter. A particularly useful application of the invention is the separation of mixed colloids. Protein mixtures can be precipitated in an upper zone, and separated by sedimentation rate differences, by isopycnic banding, or by resolubilization in a lower zone. (auth)

44178 RING DEVICE FOR CLAMPING A FLEXIBLE SLEEVE IN A CONDUIT. (to Commissariat a l'Energie Atomique). British Patent 1,198,691. 15 Jul 1970. Priority date 1 Aug 1966, France.

A ring-type device is described that is suitable for clamping a flexible sleeve around a conduit, such as might be used in a sleeve of a glove of a sealed box for permitting handling of radioactive materials in the closed box. The setting of the glove and the device can be performed from the outside without the necessity of opening the box. The ring device may be metal or other suitable material and need not be circular but must be continuous. (B.L.M.)

44179 AN APPARATUS FOR FITTING IN A CONDUIT A RING TYPE CLAMPING DEVICE FOR A FLEXIBLE SLEEVE. (to Commissariat a l'Energie Atomique). British Patent 1,198,692. 15 Jul 1970. Priority date 1 Aug 1966, France.

A device is described for use with the expandable or retractable ring-type clamping device previously described in British Patent 1,198,691. The apparatus is made up of a number of members mounted on a support, adapted to be inserted into the conduit along with the flexible sleeve, and adapted to engage a respective pair of pivotally connected elements on the ring-type clamp. (B.L.M.)

44180 APPARATUS FOR THE REPLACEMENT OF FILTER ELEMENTS. (to Ceag Concordia Elektrizitats-AG). British Patent 1,190,336. 6 May 1970. Priority date 19 Apr 1967, Germany.

Air filtering apparatus for the separation of dust injurious to health from air flowing through the duct comprises a cylindrical tube intersecting the duct transversely. The tube is open at both ends and has respective openings in its walls for the ingress and egress of air from and to the duct. The tube encloses a filter element that is provided with sealing means engaging the interior of the tube to constrain the air to flow across the tube through the filter element. The filter element is axially slidable along the tube while maintaining a seal with the tube, and the tube is at least twice the length of a filter element so that a second filter element can be pushed into place opposite the openings as a first element is pushed out to maintain the seal during changeover. (B.L.M.)

44181 IMPROVEMENTS IN OR RELATING TO FLUID COUPLINGS. Gurner, John Raymond; Henman, Lesley Arthur (to Plessey Co. Ltd.). British Patent 1,197,063. 1 Jul 1970. Filed 14 Dec 1966.

Fluid couplings including a valve that enables fluid flow to be remotely controlled is described for particular application to radioactive or toxic fluids. The coupling has two separable coupling members, together with a valve for controlling fluid flow through the coupling and a valve actuating member, which includes a hollow plunger for passage of the fluid. The plunger is arranged so that when actuated by pressure of fluid from a source remote from the coupling it opens the normally closed valve. The plunger is attached to a piston having faces of different areas and that is capable of movement in response to a pressure difference generated across the piston by fluid flowing through the coupling. The internal passage of the plunger may include a constriction such that if the rate of flow of the fluid exceeds a predetermined value an increase of pressure will occur at the constriction, tending to move the piston and close the valve. The valve actuating member may also include a non-return valve to prevent fluid leaking out and a pressure line connected to the actuating member when the coupling members have been uncoupled; the non-return valve may be located in the piston. The valve actuating member may include a movable sleeve incorporating a ball locking device, enabling it to be locked to the valve member. This sleeve may be spring loaded so that it will normally rest on the valve member in the position it would occupy if the two members were coupled together, and it may be linked mechanically to the piston so that when the piston is in a position to admit a flow of fluid through the coupling it will be held so as to lock the two coupling members together; the sleeve may thus only be withdrawn to unlock the two members when the piston is moved to a position where the valve is no longer actuated. The valve actuating member may include a normally open valve at the point of attachment to a fluid supply line, the normally open valve being arranged to close in the event of an attempt to remove the supply line from the coupling. (UK)

44182 GAS LEAK RATE MONITOR. Newman, James B. (to United States Atomic Energy Commission). U. S. Patent 3,509,758. 5 May 1970. Filed 16 Sep 1968.

A system for measuring the gas leak rate of a containment vessel includes a reference vessel positioned within the containment vessel and having an opening allowing the gas pressure in the containment vessel and the reference vessel to equalize and a flow rate meter for measuring the amount of gas flowing between the containment vessel and the reference vessel opening. By the ideal gas law the amount of gas measured by the flow rate meter is representative of the leak rate of the containment vessel. (auth)

44183 DESIGN FOR STRENGTH AND PRODUCTION. Ruiz, C.; Koenigsberger, F. New York; Gordon and Breach, Science Publishers Inc. (1970). 276p. $27.50.

Principles associated with application of basic technology to design of engineering products are examined. Chapters are included on specifications and materials, static failure, failure under cyclic loading, brittle fracture, creep failures, surface wear and corrosion, and designing for production. (J.R.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 44098, 44160, 44161, 44167, 44168, 44202, 44801, 45201, 45994, and 46055.

44184 (BNL-50205, pp 134-67) ENGINEERING DIVISION. Sheehan, T. V. (Brookhaven National Lab., Upton, N. Y.).

Investigations of cladding effects on heat transfer to liquid metals are described. Work on effects of rod displacement on heat transfer to liquid metals flowing through rod bundles is reported

along with work on heat transfer in pipes and in magnetohydrodynamic channels. In waste disposal studies, efforts were devoted to phosphate glass process and Kr adsorption. Safety studies were continued on LMFBR accident simulation. Reference design studies were completed for pulsed research reactor. (J.R.D.)

44185 (BNWL-1411) EXPERIMENTAL HIGH ENTHALPY WATER BLOWDOWN FROM A SIMPLE VESSEL THROUGH A BOTTOM OUTLET. Allemann, R. T.; McElfresh, A. J.; Neuls, A. S.; Townsend, W. C.; Wilburn, N. P.; Witherspoon, M. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 244p. Dep. CFSTI.

Safety studies simulating pressurized water and boiling water reactor hypothetical piping breaks were conducted in a 150 ft^3 vessel. High pressure water blowdowns (up to 2100 psi, 600°F) were studied with orifice diameters of 1.5 to 6.8 in. from a bottom nozzle. Internal pressure and temperature, liquid level, thrust reaction forces, weight of fluid in the vessel, void fraction of the fluid in the exit duct were measured during the blowdowns. Void fraction increased and mass velocity decreased with orifice size. Anomalous subcooled pressure behavior was thought to be caused by nitrogen dissolved in the water. Liquid level decreased nonlinearly with time, whereas mass loss rate was nearly constant for most of the blowdown. Comparisons with theoretical treatments showed the need for empirical coefficients to adjust predictions to the observed results. (auth)

44186 (CONF-670654-6) STUDY OF MIXING BETWEEN ADJACENT CHANNELS IN AN ATMOSPHERIC AIR-WATER SYSTEM. Bestenbreur, T. P.; Spigt, C. L. (Technische Hogeschool, Eindhoven (Netherlands)). May 1967. 38p. Dep. CFSTI (U. S. Sales Only).

From Symposium on Two-Phase Flow, Bournemouth, England.

The results of an experimental study of the exchange of fluid between subchannels of a multirod fuel assembly are given. The experiments were carried out with an air-water mixture in a plastic test section consisting of two coolant channels formed by a six rod square grid geometry. Air was injected in one of the channels and the mass flow of air and water was measured at the outlet of the channels. Void fraction and static pressure measurements along and across the test section were taken. The results are compared with those obtained by a theoretical analysis using the computer program HAMBO. (auth)

44187 (IEA-12) SEVERAL PROBLEMS OF HYDRODYNAMICS AND HEAT TRANSFER IN POWER REACTORS. Diegues, Jose Antonio Dias (Instituto de Energia Atomica, Sao Paulo (Brazil)). Apr 1969. 86p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The textbook used for internal seminars and based on lectures given by Dr. Gambill of ORNL at the Instituto de Energia Atomica, São Paulo, Brazil, is presented. Problems and methods of solution of heat transfer, heat transfer with phase change of condensation or evaporation, formulas for specific calculations, hydrodynamics of systems and pressure drop within a channel, and expansion and compression of a fluid are considered and illustrated. (J.S.R.)

44188 (SC-RR-70-334) HEAT CONDUCTION IN SOLIDS HAVING TEMPERATURE DEPENDENT PROPERTIES. Stewart, R. E. D.; Wessling, F. C. Jr. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 45p. Dep. CFSTI.

Approaches to heat conduction problems such as the finite element approach, the finite difference approach, and the variational calculus approach, are described. The first two approaches are presented in detail for the case of one-dimensional heat conduction in a homogeneous, isotropic material with temperature dependent properties in order to expose potential error sources which must be avoided in these approaches. Numerical results are presented for three materials having widely varying properties to illustrate the significance of the errors that can result. Several computer codes currently being used at Sandia to solve thermal problems are examined to determine if any contain such errors. (auth)

44189 (WANL-TME-1872) TAP-A: A PROGRAM FOR COMPUTING TRANSIENT OR STEADY-STATE TEMPERATURE DISTRIBUTIONS. Pierce, B. L.; Stumpf, H. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec 1969. Subcontract NP-1. 123p. Dep. CFSTI.

The program was developed to solve problems involving heat transfer in multi-dimensional systems having arbitrary geometric configurations, boundary conditions, initial conditions, and physical properties. The program can be used to evaluate internal conduction and radiation, free and forced convection, radiation at external surfaces, specified time dependent surface temperatures, and specified time dependent surface heat fluxes. (J.R.D.)

44190 THEORETICAL STUDY OF TWO PHASE FLOW DYNAMICS. Takahashi, Ryoichi; Shindo Masuo (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 96, 71-94 (Mar 1970).

Spontaneous two-phase flow oscillation which can induce reactivity instabilities in BWR was investigated with numerical simulation and the linear control theory. It is clear that the unstable flow is influenced much more by the heat transfer characteristics related to the energy storage process, than by the traditional nonlinearity of the pressure drop. The amplitude of the limit cycle originates from the degree of the stored energy at the heated wall. (auth) (Japan)

44191 TURBULENT HEAT FLUX METER AND SOME MEASUREMENTS OF TURBULENCE IN AIR FLOW THROUGH A HEATED PIPE. Bourke, P. J.; Pulling, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). Int. J. Heat Mass Transfer; 13: 1331-8(Aug 1970).

A technique was developed for determining local heat flux from simultaneous measurements of the velocity and temperature fluctuations in a turbulent fluid. The errors to which it was subject were reviewed and its accuracy was estimated from preliminary tests in air flow through a heated pipe. The results provide further data for the eddy diffusivity for heat and new data for the correlation between velocity and temperature fluctuations. (auth) (UK)

44192 CALCULATION OF HYDRODYNAMICAL CHARACTERISTICS FOR TURBULENT FLOW OF A LIQUID IN A CIRCULAR TUBE OR PLANE SLIT. Kashcheev, V. M.; Nomofilov, E. V. This paper was summarized in At. Energ. (USSR); 27: 139(Aug 1969) as paper No. 325/5073. (In Russian).

A calculation is made of the velocity distribution $\bar{u}$, the coefficients of turbulent exchange ϵ_μ, and the hydraulic resistance f in the case of steady-state turbulent flow of an incompressible liquid in a circular tube of diameter $2r_0$ and in a plane slit formed by two infinitely extended parallel slabs separated by a distance of $2r_0$. The results are used to study the possibility of using a new approximation formula for the effective velocity of the reverse flow in hydrodynamical calculations. (auth)

44193 FILM BOILING AND FREE CONVECTION HEAT TRANSFER TO CARBON DIOXIDE NEAR THE CRITICAL STATE. Abadzic, E.; Goldstein, R. J. (Univ. of Minnesota, Minneapolis). Int. J. Heat Mass Transfer; 13: 1163-75(Jul 1970).

Measurements of the heat transfer from a horizontal platinum wire to carbon dioxide over a pressure range from 0.8 to 1.1 of the critical pressure are reported. The heat transfer coefficient at conditions very close to the critical point is very large. Below the critical point in the two-phase region, film boiling appears with uprising vapor in columns or sheets. The sheets are similar in appearance to free convection flows above the critical point. Two similar relations correlate the heat-transfer measurements at bulk conditions both above and below the critical point. (auth) (UK)

44194 HEAT TRANSFER DURING BUBBLE BOILING IN A LARGE VOLUME. Subbotin, V. I.; Sorokin, D. N.; Tsyganok, A. A. At. Energ. (USSR); 28: 471-6(Jun 1970). (In Russian).

Bubble boiling was carried out in a stainless steel vessel equipped with electrical leads, thermocouples, and a condenser. Four viewing ports were provided for illumination and observations. Pictures of the bubble boiling were taken by a Fastax camera at 500 to 1100 frames/sec with frontal and side views of the bubbles. At low thermal fluxes the bubble shape was close to spherical. At fluxes greater than ~0.3 critical flux, the bubbles coagulated and formed conglomerates. The volume of the vapor conglomerates was determined from the pictures. The amount of heat carried away by the vapor did not vary by more than ±5%, when determined by 20, 50 or 100 bubbles. Experiments were carried out on water, ethyl alcohol, and carbon tetrachloride. The fraction of heat carried off by the vapor increases with increasing thermal flux at all pressures for all three liquids. Changes in boiling are related to changes in the number of vapor centers that are formed. The fraction of heat carried off in the vapor also increases with increasing heat of evaporation. An expression is given for the critical heat flux as a function of the reduced pressure and physical properties of the liquid and vapor. (TTT)

44195 BOILING OF LIQUIDS ON FINE WIRE UNDER NATURAL CONVECTION CONDITIONS. Subbotin, V. I.; Kaznovskii, S. P.; Korotaev, S. K.; Sviridenko, V. E.; Selivanov, Yu. F. This paper was summarized in At. Energ. (USSR); 26: 448(May 1969) as paper No. 289. (In Russian).

The critical thermal load in water boiling on fine wire as a func-

tion of the water composition, the diameter and material of the wire, and the conditions of thermal load was investigated. The experiments were performed under atmospheric pressure at the saturation temperature. Approximately 100 experiments produced the following results. For an impurity content of 0.1 to 1 mg/liter, the critical thermal load is independent of the wire diameter in the 0.005 to 1.8 mm range and is equal to 10^6 kcal/m^2 hr. With an increase in salinity to 20 mg/liter, the q_{cr} value increases by about 60%. The addition of 0.01 mg/liter hydrazine for a salinity of 1 mg/liter reduces the q_{cr} value by 20 to 25%. The thermal load for which bubble boiling develops increases with a reduction in the wire diameter. For diameters of 0.012 to 0.058 mm, film boiling develops outside the bubble boiling zone, while, for diameters smaller than 0.012 mm, the crisis sets in without preliminary bubble boiling. The time of preliminary boiling on wire, the manner in which the thermal load is increased (in steps, smoothly, or by shock), or the form of the electric current do not affect the q_{cr} value. (auth)

44196 CORRELATION IN DISPLACEMENT VELOCITY OF LIQUID FILM BOUNDARY FORMED ON A HEATED VERTICAL SURFACE IN EMERGENCY COOLING. Yoshioka, Keisuke; Hasegawa, Shu (Kyushu Univ., Fukuoka). J. Nucl. Sci. Technol. (Tokyo); 7: 418-25(Aug 1970).

Intense ebullition occurs at the liquid front heading a falling sheet of water over a heated vertical surface, as in the case of emergency cooling. It has been ascertained that the displacement velocity of this liquid front is nearly constant for the values of specified parameters such as wall temperature before cooling, flow rate of cooling liquid, and the physical properties of heated wall and cooling liquid. Observations were conducted on the liquid front velocity using a heated wall of stainless-steel and with tap water as cooling liquid. An analysis has been made on the basis of a two-dimensional transient heat conduction model, the result of which proves to be valid for explaining the liquid front behavior when account is taken of boiling heat transfer. The liquid front velocity is given by

$$\frac{V}{V_N} = \frac{\nu/\lambda^{1.25}}{\nu_N/\lambda_N^{1.25}} \left(\frac{G}{G_N}\right)^{1.25} \exp\left\{0.208\,\frac{T_{WN} - T_W}{100} + 0.89\,\frac{T_{IN} - T_I}{100}\right\}$$

where N denotes a reference state. The above relation is applicable in the region of flow rate from 0.245 kg/m·sec to 2.45 kg/m·sec. (auth)

44197 HEAT AND MASS TRANSFER OF RODS IN A TURBULENT LIQUID. Polyanin, L. N. This paper was summarized in At. Energ. (USSR); 26: 279-80(Mar 1969) as paper No. 263. (In Russian).

A physical description of a collection of nonuniformly heated rods is considered. The heat and mass transfer for the flow regions in hydraulic cells are discussed. A method for estimating the turbulent exchange coefficient between cells formed by a beam of cylindrical rods in a triangular lattice is presented. Results are calculated for a heat-evolving assembly to illustrate the flow distribution of coolant along the height of the cells, and the influence of turbulent diffusion on the equilibration of the coolant temperature along the cross section of the channel. The height variations of the coolant flow rate in the cells of a water-moderated, water-cooled reactor can reach about 10%. The smoothing effects of turbulent diffusion cause temperature drops to decrease by 20 to 30% or more in the coolant in neighboring cells. (auth)

44198 HIGH TEMPERATURE THERMAL CONTROL FOIL SHUTTER. Lieberman, Albert R. (to United States Atomic Energy Commission). U. S. Patent 3,519,490. 7 Jul 1970. Filed 22 Nov 1967.

A composite heat rejection louver is made of compact nonoxidizing, series-arranged foils for maintaining a relatively uniform temperature distribution on the heat surface of a radioisotope heated thermoelectric generator by selectively controlling the heat source radiation to the ambient with a radiation view factor when open and low parasitic losses when closed. (auth)

44199 PSEUDOBOILING HEAT TRANSFER TO SUPERCRITICAL PRESSURE WATER IN SMOOTH AND RIBBED TUBES. Ackerman, J. W. (Babcock and Wilcox Co., Alliance, Ohio). J. Heat Transfer; 92: 490-8(Aug 1970).

Investigations of heat transfer to supercritical pressure fluids have been going on for some time, and correlations have been developed for both free and forced-convection conditions. In these investigations, unpredictable heat transfer performance has sometimes been observed when the pseudocritical temperature of the fluid is between the temperature of the bulk fluid and that of the heated surface. The unusual performance has been attributed to many causes, but one for which more evidence is being collected is that of a pseudofilm-boiling process similar to film boiling which occurs at subcritical pressures. Experimental evidence which suggests that a pseudofilm-boiling phenomenon can occur in smooth-bore tubes is presented. During the period from 1963 to 1966, tubes with ID's from 0.37 to 0.96 in. were tested at pressures from 3300 to 6000 psia and at heat fluxes and mass velocities in the range of interest in steam-generator design. The effects of heat flux, mass velocity, tube diameter, pressure, and bulk fluid temperature on both the occurrence and characteristics of pseudofilm boiling are discussed. Results of a second series of tests conducted in 1967, which show that ribbed tubes suppress pseudofilm boiling at supercritical pressure much like they do film boiling at subcritical pressures, are also discussed. (auth)

44200 TRANSITION FROM THE TURBULENT TO THE LAMINAR REGIME FOR INTERNAL CONVECTIVE FLOW WITH LARGE PROPERTY VARIATIONS. Coon, C. W. (Southern Methodist Univ., Dallas); Perkins, H. C. J. Heat Transfer; 92: 506-12(Aug 1970).

The results of a primarily experimental study of the transition from turbulent flow to laminar flow as a consequence of high heating rates are presented. Results are reported for hydrodynamically fully developed, low Mach number flows of air and helium through a vertical, circular tube. The electrically heated section was 100 diameters in length; entering Reynolds numbers ranged from 1700 to 40,000, and maximum wall-to-bulk temperature ratios reached 4.4. As a means of predicting the occurrence of a transition from turbulent flow to laminar flow, the experimental results are compared with the acceleration parameter suggested by Moretti and Kays and to a modified form of the parameter that is appropriate to a circular tube. It is suggested that the variable property turbulent flow correlations do not provide acceptable predictions of the Nusselt number and the friction factor if the value $(4\mu q''/G^2 D T c_p) \simeq 1.5 \times 10^{-6}$ based on bulk properties, is exceeded for an initially turbulent flow situation. It is further suggested that Nusselt numbers and friction factors at locations downstream from the point $(x/D)_{laminar} \simeq (2 \times 10^{-6})\,(T_{inlet})\,(Re_{b,inlet})^2\,(T_w/T_b)^{-1}_{max}$ for bulk temperatures in degrees Rankine may be obtained from the laminar correlation equations even though the flow is initially turbulent. (auth)

44201 HEAT TRANSFER AND PRESSURE-DROP CHARACTERISTICS OF GAS FLOW INSIDE SPIRALLY CORRUGATED TUBES. Kidd, G. J. Jr. (Oak Ridge National Lab., Tenn.). J. Heat Transfer; 92: 513-19(Aug 1970).

Heat transfer and pressure-drop experiments have been performed for gas flow inside nine, ½-in-OD, 0.035-in. wall thickness, A-nickel, spirally corrugated tubes. The corrugations, which varied from 0.003 to 0.028 in. deep, were formed by pulling the tubes through a rotating head containing four embossing tools; corrugation-spacing-to-corrugation-depth ratios (P/e) ran from 16 to 41. The data, for heat transfer to nitrogen, at approximately 200 psig, were correlated by an expression of the form $N_{Nu,B}(N_{Pr,B})^{-0.4} \times (T_W/T_B)^{0.5} = A(N_{Re,B})^m$, where all the physical properties were evaluated at bulk gas conditions. The exponent, m, on the Reynolds number was observed to be consistently greater (0.854 to 0.900) than the value of 0.8 found for smooth tubes; the constant, A, varied from 0.0095 to 0.0195 with no apparent correlation with P/e. Friction factors, measured with adiabatic airflow, were found to be up to 1.7 times that for smooth tubes. Tubes of this geometry were found to be very effective in enhancing heat transfer. On an equal pumping power basis, for example, a tube with P/e = 22 had a heat transfer coefficient 22 percent greater than a smooth tube. (auth)

Isotope Technology

Refer also to abstracts 44090, 44104, 44173, 44198, 44232, 44276, 44285, 44324, 44342, 44350–44353, 44655, 44694, and 45709.

44202 (TID-25482) THE DESIGN, DEVELOPMENT, AND DELIVERY OF HIGH TEMPERATURE VACUUM INSULATION SYSTEMS FOR SNAP-21 THERMOELECTRIC POWER SYSTEM. Final Report. Niendorf, L. R. (Union Carbide Corp., Tonawanda, N. Y. Linde Div.). [1969]. Contract AT(30-1)-3691. 293p. Dep. CFSTI.

For Minnesota Mining and Mfg. Co., St. Paul.

The high temperature vacuum insulation system developed for the SNAP-21 10 W thermoelectric power system has the dual purpose of supporting the 265-pound biological shield while allowing minimum heat loss from the nuclear fuel. It is hermetically sealed and incorporates chemical getters to maintain a hard vacuum for five years. The biological radiation shield is supported by a thin-walled neck tube at the generator end and three ball joint tension support rods at the other end. The insulation has demonstrated design ruggedness by withstanding vibration load-

ings of 3 g up to 50 Hz and 6 g shock loadings at 6 milliseconds duration (saw tooth peak) while at an operating temperature of 1285°C. A thermal heat loss for the insulation system of less than 50 watts has been achieved. (auth)

44203 CALCULATED ACTIVATION OF COPPER AND IRON BY 3-GeV PROTONS. Armstrong, T. W. (Oak Ridge National Lab., Tenn.); Barish, J. Nucl. Sci. Eng.; 41: 449-51(Sep 1970).

Calculations were carried out to determine the residual nuclei production in an infinite length copper cylinder surrounded by a layer of iron exposed to a beam of 3-GeV protons located on the axis of the cylinder. The calculations were made using Monte Carlo methods to determine the nucleon–meson cascade, the residual nuclei production and the photon transport. Results are presented graphically. (J.R.D.)

44204 SURFACE REACTIONS IN AN ION SOURCE IN THE CASE OF THE ISOTOPIC SEPARATION OF THE RARE EARTHS. Nguyen Long Den; de Saint-Simon, M. (IPN, Orsay, France). pp 469-70 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The decomposition of rare earth sesquioxides in the ion source of a mass spectrometer was studied. The reducing agent is the rhenium wire on which the rare earth oxides are deposited. The ratio of the number of MO^+ ions (M = rare earths) to the number of M^+ ones, for various temperatures of the wire from 900 to 2,100°C, is measured. (auth) (France)

44205 THERMOELECTRIC DEVICES FOR SPACE AND REMOTE TERRESTRIAL SITES. Whiting, Glen; McKiernan, John (Sandia Corp., Albuquerque, N. Mex.). Mech. Eng.; 92: No. 8, 27-31(Aug 1970).

The principles and operation of thermoelectric devices are presented. Specific devices developed in the U.S. for use in space and at remote terrestrial sites, including both fossil-fueled and isotope-fueled (the SNAP systems) devices, are described and illustrated. (L.C.L.)

44206 VACUUM DISTILLATION-VAPOR FILTERED, CATALYTIC OXIDATION FOR WATER RECLAMATION USING RADIOISOTOPES FOR THERMAL ENERGY. Metzger, C. A.; Hearld, A. B.; McMullen, B.; Schelle, M. W. (Aerospace Medical Research Lab., Wright-Patterson AFB, Ohio). Aerosp. Med.; 41: 909-14(Aug 1970).

The design, development and evaluation of an in-house developed vacuum distillation-vapor filtered water recovery process are discussed. The process subjects the vapors (after distillation at low pressure) to catalytic oxidation and uses radioisotopes to obtain the thermal energy for both the distillation and catalytic oxidation. Two 32-day tests and one 42-day test produced bacteria-free, potable water. The results of this research effort on a process for reclaiming potable water from human waste (urine and condensate) has aerospace application and is considered a technological breakthrough. (auth)

44207 MASS TRANSFER MEASUREMENTS ON SUSPENDED DROPLETS. PART I. MEASUREMENT TECHNIQUE. Mensing, W.; Schuegerl, K. (Technical Univ., Hanover). Chem.-Ing.-Tech.; 42: 837-41(Jun 1970). (In German).

A new method has been developed for continuous, contactless measurement of the concentration of material dissolved in a freely suspended droplet. It is based on the optical detection with the aid of liquid scintillators of radioactively labelled dissolved material that is present in the droplets. Use of tritium-labelled tracers ensures that only those molecules given up to the droplets are monitored. (auth)

44208 ENRICHMENT OF URANIUM ISOTOPES BY GAS CENTRIFUGATION. Khan, Sikandar (Atomic Energy Centre, Lahore). Nucleus (Karachi); 6: 179-84(Oct-Dec 1969).

A brief history of the development of the gas centrifugation method for the enrichment of uranium isotopes and the theory of this process are given. The production cost of enriched uranium by gas centrifugation and other methods is also discussed. (auth)

44209 URANIUM ENRICHMENT INDUSTRY. Avery, D. G.; Kehoe, R. B. (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nucl. Energy Soc.; 9: 163-9(Jul 1970).

An outline is given of the historical development of U isotope separation and of the principles involved. The quantity known as separative work, i.e., the amount of separation an enrichment plant can achieve, is explained. Descriptions of the diffusion process and the nozzle processes are followed by a detailed description of the technology of the centrifuge method. International collaboration in centrifuge development for uranium enrichment is described. (UK)

44210 MOST POWERFUL RADIOISOTOPE HEATED THERMOLELECTRIC GENERATOR PROVIDING FOR INTACT REENTRY OF THE HEAT SOURCE MEANS FROM SPACE. Scheve, Martin R.; Young, Charles N. (to United States Atomic Energy Commission). U. S. Patent 3,520,734. 14 Jul 1970. Filed 29 Oct 1968.

An ultrahigh power, radioisotope-heated, thermoelectric generator for use in space comprises a high power density, low ballistic coefficient, radioisotope heat source for selectively removing excess heat from the heat source; thermoelectric modules for converting a portion of the heat from the heat source to electric energy while providing for the removal of waste heat from the modules; and a means for remotely inserting and separating the heat source into and from the housing for use in space and for the intact recovery of the heat source from space. (auth)

Materials Testing

Refer also to abstracts 44652, 44688, 44753, 44781, and 44827.

44211 (AERE-Bib-173) XERORADIOGRAPHY AND RELATED TOPICS. Kirk, V. M. (Atomic Energy Research Establishment, Harwell (England)). Jul 1970. 13p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

Seventy-one papers on xeroradiography are listed from 1938 onwards. Abstracts of some of the papers are included. (UK)

44212 (ORNL–4560, pp 127-8) NONDESTRUCTIVE TESTING TECHNIQUES FOR LMFBR. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

New circuit modules were constructed that are common to both the phase-sensitive instrument and the new instrument that measures both the size and depth of defects. Stainless steel welds containing intentional flaws are being examined with the schlieren system. Construction was begun on many of the components for the prototypical instrument for measuring changes in magnetic permeability in stainless steel tubing. (auth)

44213 (ORNL–4560, pp 251-60) NONDESTRUCTIVE TESTING. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Analytical work in electromagnetic theory was directed toward response to flaws in plates and design of the coils for phase-sensitive instruments. The accuracy, stability, and sensitivity of phase-sensitive type instruments were improved. Polaroid filters were used in an attempt to improve the sensitivity of an ultrasonic schlieren system. An analytical model was developed to identify the size and orientation of flaws by ultrasonic frequency analysis. Correlation is good between calculated and measured sizes for reflection both in water and in metal. Techniques were developed for accurately fabricating cylindrical reference discontinuities by means of electrodischarge machining. Parametric studies on scattered radiation spectra as a function of the angles of incident and scattered radiation were continued. For these studies, a precision goniometer and a multichannel analyzer were used. (auth)

44214 (ORNL–4576) PROGRESS REPORT ON STUDIES IN APPLIED SOLID MECHANICS. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 78p. Dep. CFSTI.

The accomplishments made during the calendar year 1969 on programs for developing structural design technology for piping components and for nozzle-to-pressure vessel attachment regions are described. These programs, being conducted in cooperation with industry through the Pressure Vessel Research Committee (PVRC) of the Welding Research Council, have as their primary objective the development of improved design methods for assuring, on a practical level, the structural integrity of the pressure vessels and primary coolant systems of nuclear power plants. The piping and nozzle programs are directed at obtaining experimental data on structural behavior and establishing experimentally proven methods of design and analysis. This information is used in the development of design rules and analytical procedures for incorporation into current industry-developed standards and USAEC Division of Reactor Development and Technology (RDT) supplemental standards. The technology is also applicable to nonnuclear systems. (auth)

44215 (UCRL-Trans-10472) NEW HIGH-TEMPERATURE AND -PRESSURE TENSILE TESTER. Onami, M.; Motoie, K. Translated by M. Shimada for Univ of California, Lawrence Radiation Lab., Livermore, from paper presented at 11th Symposium on High Pressure, Sendai, Japan, October 24–26, 1969. 8p. (CONF-691048–1). Dep. CFSTI.

The design of a tensile tester is described and illustrated. The equipment is designed so that only the specimen is exposed to the pressure field. The error in load measurement is as low as 0.2% for the entire load range. Various types of constant strain rate tests and constant load tests are possible. Specimen temperature can be controlled. Results of stress testing an Al cylinder are included. (J.R.D.)

44216 APPROXIMATE SOLUTION FOR THE BEHAVIOR OF AN ELASTIC SYSTEM UNDER AN INELASTIC IMPACT. Struck, Werner; Limberger, Ernst (Bundesanstalt fuer Materialpruefung, Berlin). Nucl. Eng. Design; 12: 452-6(1970). (In German).

For the case of an inelastic impact of short duration of a mass on an arbitrarily shaped structure with elastic response — the impact being arbitrarily directed towards the structure and with regard to the field of gravity — an approximate solution is derived for the determination of the maximum value of deflection at the location of the impact and of the representative statical load. The analysis is based on the assumption of a field of motion of the structure loaded by impact which is affined to the deflection field for a corresponding static loading. (auth)

44217 FURTHER ANALYSIS OF TWO NORMALLY INTERSECTING CYLINDRICAL SHELLS SUBJECTED IN INTERNAL PRESSURE. Maye, R. F.; Eringen, A. C. (General Technology Corp., Lawrenceville, N. J.). Nucl. Eng. Design; 12: 457-74 (1970).

The theoretical analysis of two normally intersecting cylindrical shells considered to be infinitely long, closed at their ends, and subjected to internal pressure is presented. The solution for each shell is obtained by the superposition of the solution for the shell without intersection and under internal hydrostatic pressure and the solution for the shell arbitrarily loaded along the intersection. Donnell's shell theory is used for the case of loading along the intersection with the exact solution being obtained in the form of infinite series. (auth)

44218 PROBLEM OF THE INFINITE ELASTIC PLATE WITH A CIRCULAR INSERT REINFORCED BY A BEAM. Widera, O. E. (Univ. of Illinois, Chicago); Amon, R.; Panicali, P. L. Nucl. Eng. Design; 12: 475-83(1970).

The deflection of an infinite plate with a circular insert which is reinforced by a simply supported beam and loaded by a concentrated force is determined. The problem is formulated within the framework of classical plate theory and the Euler – Bernouli hypothesis for beams. The fact that the plate, insert, and beam may possess different elastic properties is included in the solution. (auth)

44219 COMPOSITE MATERIALS: TESTING AND DESIGN. A Symposium Presented at a Meeting of Committee D-30 on High Modulus Fibers and Their Composites, New Orleans, La., 11–13 February 1969. ASTM Special Technical Publication No. 460. Philadelphia; American Society for Testing and Materials (1969). 589p. $31.00. (ASTM-STP-460; CONF-690222).

Tests now being used on composites are discussed. The problems of testing, getting the information sought after, the pitfalls, and some of the controversy surrounding testing are examined. The added difficulty of testing brought about by the use of high-modulus (advanced) fibers in composites is discussed. For instance, the shear strength test for composite materials has become a controversial subject now that high-modulus fibers are used. It was thought that shear testing was understood when glass filament reinforced plastics were tested. Now it is realized that shear in this complex advanced composites field is not well understood. (auth)

44220 INTERFERENCE OF COMPTON EFFECT IN RADIOLOGICAL DEFECTOSCOPY. Nastase, M. Gr. (Centre de Mecanique des Solides, Bucharest). Rev. Roum. Sci. Tech., Ser. Mecan. Appl.; 14: 1441-53(1969). (In French).

The rays due to the Compton effect raise serious complications in the case of a wide beam. Radiographic examination of small fragments is unhampered. These complications are expressed by the additional scattering factor which indicates the passing of the thin beam to the wide beam. This is why it is considered that this factor must imply the presence of attenuation coefficients for the two cases of irradiation. (tr-auth)

44221 QUALITY CONTROL FOR THE MANUFACTURE OF NUCLEAR ENERGY EQUIPMENT. Tsuji, Katsumi (Ebara Mfg. Co. Ltd., Tokyo). Ehara Jiho; 19: No. 73, 43-7(Mar 1970). (In Japanese).

The quality control under which nuclear energy equipment is manufactured in Japan is reviewed. (auth) (Japan)

Radioactive Material Handling

Refer also to abstracts 43989, 44091, 44174, and 44184.

44222 (BNL-50205, pp 16-25) NUCLEAR MATERIALS DIVISION. Kouts, H. (Brookhaven National Lab., Upton, N. Y.).

Activities associated with developing bases for advising the AEC Office of Safeguards and Material Management are summarized. Information is included on plant instrumentation field tests, gamma and neutron measurements of SEFOR rods, in-plant gamma measurements, neutron measurements on Pu scrap, assay of Al – Pu plates, safeguards equipment development, IAEA safeguards inspection, nuclear materials at accelerators, safeguard systems studies, and safeguard analytical laboratory evaluation. (J.R.D.)

44223 (BNWL-1336) A DETAILED ANALYSIS OF THE SAFEGUARDS CAPABILITIES OF MATERIAL BALANCE ACCOUNTING SYSTEMS IN THE LOW ENRICHED UO_2 CONVERSION AND FABRICATION SECTORS OF THE COMMERCIAL FUEL CYCLE. Wirfs, L. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 1 Jan 1970. Contract AT-(45-1)-1830. 169p. Dep. CFSTI.

Material measurement errors limit the capabilities of material accounting to detect material losses when physical inventory quantities are periodically compared to accounting balances. The measurement uncertainties in typical material balance systems of the low enriched UO_2 manufacturing facilities are characterized in this report in the form of general performance and general capability models. The safeguards capabilities of material accounting can be equated in terms of the probability of detecting a loss of material in MUF when material diversion actually occurs. An assessment is made of the detection capabilities of typical material balance systems of the UO_2 manufacturing cycle. (auth)

44224 (BNWL-1399) SAFEGUARDS CAPABILITIES OF THE MATERIAL BALANCE ACCOUNTING SYSTEMS OF THE PLUTONIUM PROCESSING AND SCRAP RECOVERY OPERATIONS AT HANFORD. Wirfs, L. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT-(45-1)-1830. 127p. Dep. CFSTI.

The measurement uncertainties in typical material balance systems of the plutonium processing and scrap recovery operations at Hanford are characterized in terms of general performance, intermediate improvements, and general capability models. Both the random and the systematic components of error are identified for individual measurements. Material measurement errors inherently limit the control capabilities of material balance accounting systems. The safeguards capabilities of material accounting are equated in terms of the probability of detecting a loss of material in MUF when material diversion actually occurs. An assessment is made of the detection capabilities of the material balance systems described in the study models. (auth)

44225 (CEA-N-1291) SAFETY-CRITICALITY: RECOMMENDATIONS CONCERNING THE STORAGE OF FISSILE MATERIALS. (Commissariat a l'Energie Atomique, Paris (France)). Jun 1970. 37p. (In French). Dep. CFSTI (U. S. Sales Only).

General instructions relating to design and use of storage locations for fissile materials are given. Some standards are proposed and examples are given for storage of enriched uranium or plutonium in the form of ingots, solutions, solid waste, or fuel elements. (auth) (France)

44226 (CONF-700810-7) ARRANGEMENTS FOR THE CONTROL OF RADIOACTIVE WASTES ASSOCIATED WITH THE FAST REACTORS DEVELOPED IN FRANCE. Candes, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1970]. 17p. (In French). (SM-146/49). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

France is putting a great deal of effort into the development of electric power stations using sodium-cooled fast reactors. These efforts are typified by the reactors RAPSODIE (in operation), PHENIX (under construction) and PHENIX 1000 MW (in the pre-

project stage). The various arrangements made to limit the spread of radioactivity produced in normal reactor operation or released during an accident are described. (auth)

44227 (CONF-700810-44) STATUS OF SOLIDIFICATION AND DISPOSAL OF HIGHLY RADIOACTIVE LIQUID WASTES FROM NUCLEAR POWER IN THE USA. Schneider, K. J.; Blasewitz, A. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Bradshaw, R. L.; Blomeke, J. O.; McClain, W. C. (Oak Ridge National Lab., Tenn.). [1970]. 34p. (SM-146/23). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Research and development has been carried out to develop processes for converting the high-level liquid wastes to encapsulated solids such as spray solidification, pot calcination, phosphate glass solidification, and fluidized bed calcination. All processes are being demonstrated on an engineering scale with radioactive wastes. In all four processes, the waste is heated to 400 to 1200°C to drive off essentially all of the volatile constituents, leaving a solid or a melt that will cool to a solid. Disposal of these radioactive wastes requires isolation from the biological environment for hundreds of thousands of years. Natural salt deposits were concluded to be the most promising disposal locations for meeting these criteria in the USA. A concept for a facility to dispose of containers of solidified highly radioactive waste in a salt mine has been investigated in an experiment in a salt mine. The overall disposal concept, as well as equipment requirements and handling techniques, were demonstrated. The cost of high-level waste management involving solidification in combinations with interim liquid storage, interim solid storage, transportation to final disposal, and disposal in a salt mine has been estimated to be about 35 to 50 mils/MWh(e), or only slightly higher than the cost range for perpetual liquid storage. (auth)

44228 (KFK-1138) DEEP STORAGE OF RADIOACTIVE WASTE. ANNUAL REPORT, 1968. Borchert, H.; Duerr, K.; Klarr, K.; (and others) (Kernforschungszentrum, Karlsruhe (West Germany)). Dec 1969. 35p. (In German). (GSF-T-25). Dep. CFSTI (U. S. Sales Only).

Research done on the underground storage of radioactive wastes under the auspices of the radiation research centers of Karlsruhe and Munich is briefly reported. These studies include consideration of low-activity, high-activity, and medium-activity wastes, extension of existing storage caverns, and the effects of temperature and hydrologic factors on the storage safety. The deposition of radioactive wastes in containers in the Atlantic is also discussed. (J.S.R.)

44229 (RFP-1499) CALCULATIONS FOR PIPE INTERSECTIONS CONTAINING FISSILE SOLUTION. Dickinson, Deanne (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 24 Jun 1970. Contract AT(29-1)-1106. 20p. Dep. CFSTI.

Calculations of the effective neutron multiplication factor (k_{eff}) for complicated pipe intersection problems have been performed using the O5R Monte Carlo neutron transport code. Results are compared with experimental data and with the predictions of an earlier empirical model, identified as the AI Model. Calculations for simple pipe intersections such as T's and crosses are also presented. A new empirical model is formulated and its predictions compared with experimental and calculational data and with other model calculations. (auth)

44230 (Y-CDC-7) URANIUM METAL CRITICALITY, MONTE CARLO CALCULATIONS AND NUCLEAR CRITICALITY SAFETY. Thomas, J. T. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 5 Aug 1970. Contract W-7405-eng-26. 64p. Dep. CFSTI.

The criticality of cuboidal arrays of subcritical uranium-metal components is explored with the KENO Monte Carlo code. A sufficient number of critical experiments is described and calculated with the code using the Hansen-Roach cross-section sets to adequately verify the use of this combination to examine array conditions of interest to nuclear criticality safety. The magnitudes of changes in array reactivity associated with a number of safety considerations, usually compensated by arbitrary safety factors, are presented. Among these is a Δk_{eff} of about 4% associated with the rearrangement of the units in an array from a square to a triangular pattern together with the necessary adjustment in the lattice cell size. The effect of unit, cell, or array shape on the array reactivity is shown to lead to increases in the safety margins usually employed and to correspond to approximately 0.2 in Δk_{eff}, except that extreme distortions of cell shapes can lead to increases in reactivity. The Transport Index Rule, as implied and used in the Code of Federal Regulations, is examined and proof is offered of its general applicability in transport and storage of fissionable materials. A method of interpreting the influence of the degree of reflection about an array is presented and suggestions are made for its general implementation. Calculated criticality conditions for reflected and unreflected planar arrays are presented and interpreted in terms of surface density criteria in nuclear criticality safety problems. It is suggested that cuboidal array criticality is sufficiently defined to allow its use as a unifying basis in the practice of nuclear criticality safety in storage and transport problems. (auth)

44231 MEMORANDUM ON APPROVED METHODS FOR THE SHIPMENT OF NUCLEAR FUEL MATERIALS. Blechschmidt, M. PTB Mitt.; 80: No. 1, 34-9(Feb 1970). (In German).

Paragraph 4 of the Law for Peaceful Application Of Atomic Energy of the Federal Republic of Germany is presented with comments as of December 1969. The paragraph deals with general aspects of nuclear fuels, application for permission to transport nuclear materials, description of amount and type of nuclear fuel, requirements for containers, means of transportation, legal definition of liability, protective measures against interference by third persons, and cost of legal procedures. Ten references are given. Two tables represent legal requirements for international transportation of nuclear materials by surface and air vehicles. (H.B.G.)

44232 NUCLEAR CRITICALITY SAFETY ASPECTS OF ^{238}Pu. Wolfe, Richard A. (Monsanto Research Corp., Miamisburg, Ohio). Nucl. Appl. Technol.; 9: 218-28(Aug 1970).

Calculations show that a 10% isotopic abundance of ^{238}Pu in a bare spherical $^{239}Pu-H_2O$ system increases the minimum critical mass by approximately 48%, thereafter the increase continues exponentially. These results, in addition to several subcritical neutron multiplication experiments with ^{238}Pu in both solution and dioxide form, confirm that ^{238}Pu behaves as a neutron poison in a well-moderated medium. Neutron multiplication experiments were conducted with four SNAP-19B (IRHS) heat sources with (approximately 1 kg ^{238}Pu per source.) The results indicated that a neutron multiplication less than 1.2 existed when the heat sources were assembled in different array configurations. The criticality unit value for ^{238}Pu in either solution or dioxide form has been conservatively established at 2.0 kg. Thermocouples installed on process vessels have proven to be a new criticality control technique for determining gradual ^{238}Pu sludge build-up. Heterogeneous water-filled storage vaults provide the safest method for storing large quantities of PuO_2 containing at least 76% ^{238}Pu. (auth)

44233 MANAGEMENT OF RADIOACTIVE WASTES. PRINCIPLES AND MEASURES TAKEN IN THE MATTER OF WASTE EVACUATION. Williams, Ian (European Nuclear Energy Agency, Paris). OECD (Organ. Econ. Coop. Develop.) Observ.; No. 45, 31-6(Apr 1970). (In French).

Almost all materials used in nuclear plants can at some time or another be considered as radioactive wastes, and raise management problems of a more complex kind than those encountered in other fields. The greatest possible attention must be paid to public health and human environment, the solutions chosen depending on their comparative cost and relative convenience. How these considerations can be applied to given types of wastes (gas, liquids, solids) is discussed. (auth) (France)

44234 FISSIONABLE MATERIAL CONTROL FROM THE INDUSTRIAL VIEWPOINT. Stoll, W. (Alpha-Chemie und -Metallurgie GmbH., Wolfgang, Ger.). Atomwirt., Atomtech.; 15: 370-7(Aug 1970). (In German).

Problems of detecting accidental or intentional loss of fissionable material during the reprocessing of nuclear fuels are discussed. Industry has primary interest in strict control of fissionable material for reasons of personnel safety. The more effective the industrial control is, the easier surveys can be performed by international controllers. Principles of monitoring fissionable material are given in three diagrams of a fast breeder reactor, a fuel reprocessing plant, and a general production plant. All methods and their results presently applied in Germany are tabulated. Data about containment vessel, fuel elements, direct measurements of plutonium, indirect measurements of plutonium, and indirect measurements of uranium are listed. A cost analysis for control measures is presented and the results tabulated. (H.B.G.)

44235 IMPROVEMENTS IN AND RELATING TO TRANSFER LOCKS. Jahan, Jacques; Vertut, Jean (to Commissariat a l'Energie Atomique). British Patent 1,201,748. 12 Aug 1970. Priority date 17 May 1968, France.

A transfer lock is described that comprises a sealing-tight

chamber closed by two removable doors, one door connecting the lock to a sealing-tight vessel and the other door connecting the lock to the space outside the vessel. The lock is suitable for use on a shielded cell for use with radioactive materials. The transfer lock is made up of a scavenging air ventilation circuit whose output directly supplies the vessel. The sealing-tight chamber is disposed between two filters connected in series in the air circuit. (B.L.M.)

Vacuum Engineering

Refer also to abstract 44202.

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 44222.

General Detectors and Monitors

Refer also to abstracts 44326, 44369, 45713, 46021, 46026, 46097, 46099, and 46135.

44236 (AD–703616) COINCIDENT NEUTRON EQUIPMENT. Strain, Charles V.; Omohundro, Robert J. (Naval Research Lab., Washington, D. C.). Mar 1970. Contract ACDA/ST/RA-46. 51p. (NRL-MR-2107). CFSTI.

Coincident neutron detectors have been developed which can distinguish between neutrons occurring as a result of fission and those due to (α,n) or (γ,n) nuclear reactions. These detectors are described and several examples of their use are reported. Theoretical relations which predict count rates as a function of sample and equipment characteristics are developed. These permit the potential usefulness of coincidence measurements to be ascertained for any given set of circumstances. (auth) (USGRDR)

44237 (BARC–456) SURFACE BARRIER DETECTORS. Chaudhry, Ramesh (Bhabha Atomic Research Centre, Bombay (India)). 1970. 18p. Dep. CFSTI (U. S. Sales Only).

A large number of gold-silicon (n-type) surface barrier detectors have been fabricated with a very good yield. The technique adopted is described. Detectors have been made with more than 2 cms. diameter and up to 0.5 mm depletion depth. Measurements made on the capacitance of these detectors and its variation with reverse bias are presented. (auth)

44238 (BNWL-SA-3069) IN VIVO COUNTING WITH GeLi. Andersen, B. V.; Bramson, P. E.; Rising, F. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 27 May 1970. Contract AT(45-1)-1830. 9p. (CONF-700609-2). Dep. CFSTI.

From 15th Annual Meeting of the Health Physics Society, Chicago, Ill.

A whole-body counter using four lithium-drifted germanium detectors is described. The resolution, sensitivity, and angular response of the germanium detectors are compared to those of a sodium iodide scintillation detector. (W.H.K.)

44239 (CEA-CONF-1541) NONDISPERSIVE X-RAY SPECTROMETRY WITH Si(Li) AND Ge(Li) DETECTORS. Friant, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 10 Jun 1970. 41p. (In French). (CONF-700619-1). Dep. CFSTI (U. S. Sales Only).

From Annual Meeting on Electronic Probe Analysis, Lille, France.

Significant improvements on energy resolution of spectrometry units with narrow-window Si(Li) and Ge(Li) detectors, open bright prospects for X or γ photon spectrometry (energy greater than 1 keV). After a brief description of such an X spectrometry chain, the principal parameters of the detectors are successively studied: resolution energy, detection threshold, efficiency, etc. The technology of high performance Si(Li) and Ge(Li) detectors designed in the laboratory as well as performances expected of them in the near future (100 eV to 6 keV) will lead to a number of applications including non-destructive and rapid analysis by X-fluorescence association with electronic micro-probes. (France)

44240 (CEA-N-1287) GAMMA ABSORPTIOMETER FOR IN-LINE MEASUREMENTS OF HEAVY ELEMENT CONCENTRATION IN SOLUTION USING A SCINTILLATION DETECTOR AND A PHOTOMULTIPLIER. Edeline, Jean-Claude; Quemere, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1970. 37p. (In French). Dep. CFSTI (U. S. Sales Only).

A study was made of the characteristics of a current controlled scintillator to be used as a logarithmic response detector for a gamma absorptiometer; this apparatus can carry out in line measurements of heavy element concentrations in solution. The following factors were studied: gain changes in the NaI(Tl)–PM device as a function of the HT, the γ flux and the temperature; the long-life components of the phosphorescence of the scintillator; the variations in the HT as a function of the flux at constant anode current. In conclusion, the possibility was considered of building an apparatus having an output signal proportional to the heavy element concentrations of the solution; this could be realized by using a plastic scintillator containing 10% lead. (France)

44241 (CEA-N-1298) MINIATURE FISSION CHAMBERS CFUE22–CFUE32. Bacconnet, Eugene; Duchene, Jean; Farcy, Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 9 Feb 1970. 31p. (In French). Dep. CFSTI (U. S. Sales Only).

The fission chambers considered are built into a stainless steel aluminized triaxial structure with a built-in insulated triaxial semi-rigid cable having a characteristic impedance of 50 Ω and a length of up to 12 meters. The diameter of the chamber is 8mm and that of the cable 6mm. The sensitivities of the two types are respectively 10^{-2} c/s and 10^{-3} c/s for a flux of 1 n/cm^2/s. These chambers which support high neutron fluxes and strong gamma radiations are studied for their possible applications at high temperatures (600°C). (France)

44242 (CEA-N-1320) METHOD OF MEASUREMENT FOR EVALUATING THE TRANSPARENCY OF ENTRY WINDOWS OF Ge(Li) SEMICONDUCTOR TO γ AND X PHOTONS. Pascal, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1970. 16p. (In French). Dep. CFSTI (U.S. Sales Only).

A method is proposed for determining experimentally the transmission curve as a function of the energy of the entry window of Ge(Li) detectors using the ratio of the surfaces of two peaks in a γ spectra produced by a simple emitter. The sources used do not have to be calibrated. The energy $E\phi/2$ of the photon for which the transmission is 50% makes it possible to define the entire transmission curve. The energy range $E\phi/2$ covered is from 10 to 70 keV, with 3 emitters: ^{57}Co, ^{241}Am, and ^{153}Gd. (France)

44243 (CONF-691101–, pp 516-36) EXPERIMENTAL ERROR PROPAGATION IN UNFOLDED STRAY NEUTRON SPECTRA. Weinstein, Martin S.; Sanna, Robert S.; McLaughlin, James E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

The Health and Safety Laboratory has used neutron energy spectra from nuclear track emulsion and Bonner multisphere measurements for comparison with theoretical results and for understanding stray neutron dosimetry problems. Employing a priori conditions of non-negativity and smoothness, appropriate energy spectra are inferred from measurements with both spectrometers using iterative unfolding. Errors may occur both in the observed measurement distribution and response matrix for either system. The effects of error propagation on unfolded spectra and specific dose equivalents derived for each spectrum are described assuming that the response matrices are well known. Synthetic measurement distribution data are derived from known neutron spectra and randomly perturbed to simulate real experimental errors. The perturbed data are then unfolded to obtain a range of spectra useful for estimating the errors in the unfolded spectrum. For the emulsion system, Monte Carlo techniques are employed to generate realistic recoil proton track distributions from test neutron spectra. For the multisphere system, test neutron spectra are folded into the response matrix yielding measurement distributions and unfolded spectra are inferred for each of several assumed systematic errors. (auth)

44244 (CONF-691101–, pp 746-9) TELEMETERING–ANOTHER APPROACH TO EXPOSURE CONTROL. Smedley, Charles E. (College of William and Mary, Newport News, Va. Space Radiation Effects Lab.).

The advantages and use of a telemetering system with a Geiger–Mueller detector for dosimetry of personnel engaged in the operation and maintenance of a cyclotron are discussed. (W.H.K.)

44245 (EUR–4452, pp 219-33) WALL-LESS COUNTERS AND THE LINES OF THEIR FUTURE DEVELOPMENT. Emery, E. W. (Hammersmith Hospital, London (England). Medical Physics Dept.).

When a proportional counter is used to simulate a small tissue volume, the wall may introduce artifacts both from geometrical causes and possibly also through differences in the slow electron spectrum in gas and solid material of similar atomic composition. A wall-less counter avoids these difficulties but introduces uncertainties in the extent of the simulated volume. These various problems are examined. Conventional counters with walls will probably prove the more convenient instruments for the routine examination of radiation fields; but careful comparison with wall-less counters will be necessary to establish the corrections necessary for the wall-effects. For the simulation of complex situations, such as the observation of simultaneous events in several associated microscopic volumes, wall-less counters offer wide scope, and it will be difficult to find substitutes for them. (auth)

44246 (EUR–4452, pp 235-48) PRELIMINARY MEASUREMENTS WITH A CYLINDRICAL WALL-LESS COUNTER. Wilson, K. S. J. (Hammersmith Hospital, London (England). Medical Physics Dept.).

The design of a cylindrical wall-less counter is described. The definition of the sensitive volume, and hence the working conditions of the counter are determined by the measurement of its saturation curves when irradiated with ^{60}Co γ-rays. (auth)

44247 (EUR–4452, pp 249-65) MICRODOSIMETRY OF DIRECTLY IONIZING PARTICLES WITH WALL-LESS PROPORTIONAL COUNTERS. Gross, William; Biavati, B. J.; Rossi, H. H. (Columbia Univ., New York).

The possible distortions of the pulse height spectra from walled proportional counters used for microdosimetric measurements due to the change in density of wall to gas have led to the development of counters with a minimum of wall material. Such "wall-less" counters have the additional advantage of making the measurement of spectra from directly ionizing particles possible. These spectra are remarkable primarily because of the large contribution from delta rays of directly ionizing particles which themselves do not enter the ionization volume. The contribution from these delta rays becomes more important as the simulated size becomes smaller. Alpha particle spectra for sizes down to 0.5 μm have been obtained and a method to determine event spectra with small accelerator beams developed. (auth)

44248 (EUR–4452, pp 269-81) WALL EFFECTS OF SPHERICAL PROPORTIONAL COUNTERS. Oldenburg, U.; Booz, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The spectral distribution of the energy transferred by monoenergetic neutrons to a spherical proportional counter of tissue equivalent material is calculated by a Monte Carlo program. This programme considers all neutron reactions with the elements H, C, N, O, F, Si, and Ca which are energetically possible in the energy range to 6 MeV. By an analysis of all multiple events the following two types of wall effects are investigated: (1) the increase in the average absorbed energy per primary neutron due to multiple scattering; and (2) the increase in the average absorbed energy per primary neutron resulting from the simultaneous registration of two or more ionizing particles produced by a neutron reaction in the wall. Investigations on the wall effect due to the scattering of weak electrons and delta-rays are not dealt with. (auth)

44249 (EUR–4452, pp 283-301) RANDOMNESS. Katz, Robert (Nebraska Univ., Lincoln. Behlen Lab. of Physics).

Though the word random may be properly applied only to a process, it is often applied to the output of that process, as in the case of "random number tables." Note the circulatory of the terminology. Only the process is random, but it is only through study of the output that the randomness of the process can be evaluated. A device is random only if it is ahistoric, that is if its future output depends in no way upon the past. In the application of random number generators it is usually desired that the output could have been generated with good probability from a perfectly random generator. To test randomness, certain selected characteristics are compared with predicted properties of an idealized random generator. For some purposes, as in simulation of dose-response properties, the number of hits and their distribution is a meaningful property. This leads to a new test of randomness, in which the actual tally of t times repeated numbers (after n draws) is compared to the prediction of the binomial distribution. Number sequences which fail this test badly, for it is very unlikely that a perfectly random generator would display the developed pattern of hits, yield the expected number of O-hit cases (survivors), implying that the 1-hit process is a weak test of randomness. The Poisson estimate of exponential survival may be a good estimate of the actual number of survivors in situations where the distribution of events is not poissonian. (auth)

44250 (EUR–4452, pp 327-41) DEVELOPMENT OF A LIGHTWEIGHT, ROBUST LET SPECTROMETER. Day, B. (Atomic Weapons Research Establishment, Aldermaston (England)).

An LET Spectrometer, based on the spherical proportional counter introduced by Rossi, has been developed which weighs about 30 kg. (This weight includes 20 kg due to the pulse height analyzer.) The weight reduction is achieved by using a sealed system containing air instead of maintaining a flow of tissue equivalent gas. The vibration sensitivity has been effectively eliminated by using shaped insulators instead of the helical wire to maintain the correct field distribution. The system has been operated in neutron fields of various energies and shown to produce pulse size distributions which are essentially identical to those produced by an unmodified Rossi counter in the same field. (auth)

44251 (EUR–4452, pp 343-62) A RECOMBINATION IONIZATION CHAMBER SYSTEM AS A SENSITIVE, THREE CHANNEL LET INDICATOR FOR STRATOSPHERIC USE. Wilson, I. J. (Atomic Weapons Research Establishment, Aldermaston (England)).

In the development of the Concorde In-Flight Radiation Warning Meter, a system was required to indicate the different qualities of stratospheric radiation encountered at different altitudes during a single flight. As proportional counter LET spectrometers lack the necessary sensitivity, a system of three recombination ionization chambers has been developed to operate in dose rates of 0.1 – 1 millirad/hr with a response time of a few minutes. Each chamber has a working volume of about 6 liters and can be pressurized to 10 atmospheres with tissue equivalent gas. The chambers are calibrated by collection efficiency measurements made with low LET (gamma), medium LET (recoil proton) and high LET (internal alpha) radiations: three distinct polarizing voltages were selected for operational purposes. The chambers were used to measure the stratospheric radiation situations on the ascent to and descent from 30,000 m during balloon flights. The three chamber system will be compared with the AWRE transportable LET spectrometer in mixed radiations simulating stratospheric situations resulting from cosmic and solar flare protons etc., interacting with the earth's atmosphere. (auth)

44252 (EUR–4452, pp 363-72) DEVELOPMENT OF A COINCIDENCE-COUNTER TO MEASURE THE ABSORBED ENERGY INSIDE THE CELL FOR BETA-EMITTERS DEPOSITED IN THE CELLMEMBRANE. Handl, J.; Kuehn, W. (Gesellschaft fuer Strahlenforschung m.b.H., Munich (West Germany). Institut fuer Strahlenbotanik).

The investigation of exchange processes and permeability problems of the cell membranes is often executed by means of radioactive tracers. This may result in an accumulation of radioactive materials inside of more or less thin layers below the cell surface. Since the radiosensitivity of the interior parts of the cell esp. the cell nucleus is normally higher than that of the cell membrane it is necessary to know the radiation burden of the cell volume due to the radioactive decay of nuclides deposited in a surrounding shell. This problem can be checked by the experimental simulation in a special proportional counter device. The counter which is now under construction contains three concentric electrodes and will be filled with tissue-equivalent gas which can be labelled e.g., by ^{3}H or ^{14}C. By coincidence electronics the fraction of particles can be selected which decays between the two outer electrodes and contributes to the ionization between the interior electrodes. Spectrometric measurements will be included. (auth)

44253 (EUR–4452, pp 437-53) MEASUREMENT OF DEPTH DOSE DISTRIBUTIONS DEPOSITED IN A PLEXIGLAS PHANTOM IRRADIATED WITH A BEAM OF 10-, 15-, 20-, OR 30-MeV MONOENERGETIC ELECTRONS. Mathieu, Jacques; Blanc, Daniel; Casanovas, Joseph (Toulouse Univ. (France). Centre de Physique Atomique et Nucleaire); Dutreix, Andree (Institut Gustave Roussy, Villejuif (France)); Wambersie, Andre; Prignot, Michele (Louvain Univ. (Belgium)). (In French).

The ionization produced in depth in a Plexiglas phantom irradiated by a monoenergetic electron beam was measured by means of an ionization chamber with dielectric liquid. The sensitive volume is a thin film of liquid (0.9 mm thick), the electrodes are beryllium discs 0.5 mm thick and the chamber walls are of Plexiglas. The in-depth yield was measured for 10, 15, 20, and 30 MeV electrons; the results are compared with those obtained with a Baldwin chamber and with a ferrous sulphate dosimeter. (auth)

44254 (EUR–4452, pp 631-52) PARTICLE TRACKS IN EMULSION. Katz, Robert (Nebraska Univ., Lincoln. Behlen Lab. of Physics).

Both the response of nuclear emulsions to electron beams, and the structure of the tracks of charged particles are well described by a theory which assumes that the dose-response curve is one of exponential survival, or "1-hit to dose." Calculated blackness-fluence curves are in good agreement with experimental data obtained with G.5 and K.2 emulsions bombarded with normally incident electron beams at incident energies between 7 and 60 keV. Calculations of the microdose distribution surrounding a particle track make it possible to calculate the structure of particle tracks from the same dose-effect relationship, attributing the observed effect to the energy deposited by delta rays. The construction of the theory is identical with earlier work on the theory of RBE and of NaI(Tl). The non-Poissonian (non-random) character of the distribution of the energy deposited in a sensitive volume seems not to play a significant role here, as in earlier work on physical systems whose response is "1-hit to dose," and whose "size" is less than a micron (enzymes, viruses, NaI(Tl), emulsion grains). (auth)

44255 (INR–1184) A RIG FOR THE MEASUREMENTS OF THE TEMPERATURE DEPENDENT CHARACTERISTICS OF THE

RJ-200 IONIZATION CHAMBERS. Yanikovskii, A.; Kot, Ya. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

This report summarizes the first stage of the realization of the program concerning the neutron detector properties investigation in the temperature range up to 500°C. The description of the laboratory stand for measurements of the temperature effects on RJ-200 ionization chamber characteristics is presented. Also the measured results of the heat transfer and temperature distribution in this experimental facility are discussed. (auth)

44256 EFFECT OF ELECTRON-BACKSCATTERING ON THE SENSITIVITY OF IONISATION CHAMBERS. Patsch, R.; Wensel, A.; Wittig, S. (Johann-Wolfgang-Goethe Univ., Frankfurt am Main). Kerntechnik; 12: 294-7(Jul 1970). (In German and English).

The sensitivity of cylindrical ionization chambers made of various materials was determined experimentally for activated air (argon 41) as chamber filling gas. The sensitivity was also calculated by a Monte Carlo method taking into account electron-backscattering from the wall of the ionization chamber. Good agreement was found between experimental and calculated results. The Monte Carlo method was also used to investigate the dependence of sensitivity on the shape of ionization chambers. (auth)

44257 STANDARDIZATION OF LINEAR CIRCUITS IN NUCLEAR PULSE MEASURING SYSTEM. Matoba, M.; Katase, A.; Sonoda, M. (Kyushu Univ., Fukuoka). Jap. J. Appl. Phys.; 9: 816-19(Jul 1970).

An attempt of standardization of linear circuits in nuclear pulse measuring systems is described. By the use of one circuit block, a number of transformations of linear pulses were accomplished. An operational amplifier fulfilling the above-mentioned requirements was designed. (auth)

44258 PHYSICAL AND ENGINEERING CRITERIA FOR THE DEVELOPMENT OF SEMICONDUCTOR BARRIER LAYER PROBES FOR THE INCORE MEASUREMENT OF NEUTRON FLUX DENSITY IN REACTORS. Graul, J.; Ruge, I. (Technische Hochschule, Munich). Kerntechnik; 12: 291-3(Jul 1970). (In German and English).

On the basis of characteristic alterations of semiconductor parameters by radiation damage, it is possible to choose for the design of a radiation-resistant barrier layer probe a semiconductor structure such that the lifetime mobility ($\mu\tau$) of the charge carriers decreases only slightly at an anticipated radiation fluence. As this product $\mu\tau$ governs the diffusion length and the length of travel of the charge carriers, the signal amplitude also may be reduced. The largest possible signal amplitude for a given radiation exposure is estimated on the assumption that the variation of the signal amplitude owing to radiation damage during a specified service time must not exceed a specified error limit. (auth)

44259 ENHANCEMENT OF TRACK ETCHING BY A SPARK DISCHARGE. Blanford, G. E. Jr.; Walker, R. M.; Wefel, J. P. (Washington Univ., St. Louis). Contracts Z-80058T; NAS 9-8352. Radiat. Eff.; 3: 263-6(Jun 1970).

It is found that the rate of track etching of heavy-ion tracks in Lexan polycarbonate is greatly increased when the track-containing plastics are stored in a container in which a spark-discharge is occurring. A series of simple experiments, using a Tesla coil as the spark source, were conducted that have led to the view that the effect is caused by the interaction of excited gas species with the stored tracks. It does not appear to be caused either by a direct electrical effect of the discharge or by light given off by the spark. This new effect can potentially be used as a method to both sensitize and stabilize plastics containing charged-particle tracks. (auth)

44260 SCATTERING OF 14 MeV NEUTRONS. III. Azuma, Toshio; Sato, Yuji. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 27-8(1969).

The pulse shape discrimination (PSD) method is tried to measure 14 MeV neutrons in the time of flight system using liquid scintillator NE213-56AVP. The half-width of elastically scattered neutrons from carbon is 0.5 ns and the inelastically scattered neutrons from 4.4 MeV level is 2.3×10^{-7} α. (auth)

44261 EFFECTS OF CONTAMINANTS IN METHANE AS A PROPORTIONAL TUBE COUNTING GAS. Armstrong, F. E.; Howell, W. D.; Whitlock, D. W. (Bartlesville Petroleum Research Center, Okla.). Nucl. Appl. Technol.; 9: 107-11(Jul 1970).

An investigation has been made of the effects of helium, ethane, propane, nitrogen, and carbon dioxide as contaminants in methane used as the filling gas for a proportional counting tube. The concentration of contaminant was similar to that normally encountered in natural gas. It was found that the principal effect was that of change in gas multiplication factor and that compensation may be made by an appropriate change in applied bias voltage. (auth)

44262 EVALUATION OF CdTe AS AN INTEGRAL GAMMA-RAY COUNTER. Nichols, H. H. (Lockheed Nuclear Lab., Dawsonville, Ga.); Palms, J. M. Nucl. Appl. Technol.; 9: 112-19 (Jul 1970).

The integral gamma-ray counting efficiency was measured for six CdTe detectors using gammas from ^{57}Co, ^{85}Kr, ^{137}Cs and ^{60}Co. Changes in efficiency were measured as a function of temperature (−50°C to 66°C), detector bias (50 volts to 100 volts), pulse clipping time (0.25 μ sec to 1.6 μ sec) and energy threshold setting (25, 50, 75 and 100 keV). The change is mainly due to trapping and detrapping of charge carriers. For a clipping time of 1 μsec changes in efficiency as high as 300% were observed over the temperature range −50°C to 66°C. This change in efficiency was reduced to less than 10% by using only the fast component of the pulses generated. Total gamma-ray efficiency approaching the theoretical limit was measured at 23°C. Presently CdTe detectors are not intended for use as spectrometers, but are intended to be used as gamma-ray counters over a wide temperature range. (auth)

44263 ELECTRON MULTIPLIER EFFICIENCY FOR HYDROGEN ATOM DETECTION. McKnight, R. H.; Crandall, D. H.; Jaecks, D. H. (Univ. of Nebraska, Lincoln). Rev. Sci. Instrum.; 41: 1282-3(Sep 1970).

The efficiency of an electron multiplier for detecting fast hydrogen atoms has been measured by a coincidence technique employing Lyman α photons from the induced decay of metastable hydrogen atoms. Results reported are for the energy range 3 to 20 keV. (auth)

44264 NUCLEAR RADIATION DETECTORS WITH THE USE OF A CADMIUM TELLURIDE SEMICONDUCTOR. Vavilov, V. S.; Vagapov, R. Kh.; Chapnin, V. A.; Chukichev, M. V. At. Energ. (USSR); 28: 505-6(Jun 1970). (In Russian).

Samples of semiconductor CdTe of two types were used: A_2 and B. The sample resistances were within the limits of 10^6 to 10^8 ohm-cm. Samples of the B type were obtained by thermal treatment of CdTe of the p-type (initial resistance of 10^4 ohm-cm) in saturated cadmium vapor at 500 to 700°C. In this case a high sample resistance was apparently attained as a result of the compensation of acceptors by internodal cadmium atoms which are donors. Samples of the A_2 type were obtained because of compensation of fine-grained donors in the initial material of the n-type (resistance of 0.1 ohm-cm) by acceptor centers A_2 which are formed during thermal treatment in vacuum at 500 to 600°C. The detector thickness was ~1 mm with indium, gold or palladium being used as electrodes. The B-type detector showed typical diode characteristics, while the A_2 detector had ohmic properties. In alpha particle detection the efficiency of charge collection is 100% in type-B material, and only ~40% in detectors of type A_2. The poor energy resolution and form of the spectral curves shows that the samples are very inhomogeneous over the detector volume. The efficiency of counting 663 keV gamma quanta from Cs-137 is about 0.5% with a sensitive layer 1 mm thick. The same efficiency (0.5%) can be attained also in counting thermal neutrons with these semiconductor detectors. (TTT)

44265 MEASURING FLUXES OF NUCLEONS HAVING AN ENERGY GREATER THAN 600 MeV. Borodin, V. E.; Zotov, A. V.; Kimel, L. R.; Lebedev, V. N.; Sidorin, V. P. At. Energ. (USSR); 28: 506-7(Jun 1970). (In Russian).

High-energy fluxes of accelerator particles were detected by gold foil detector 0.1 mm thick and 60 mm in diameter by means of the following spallation reaction: Au-197(p,spall)Tb-149. The Tb-149 activity has a 4.1 hr half-life, and emits 3.95 MeV alpha particles which were detected by a ZnS scintillator. The threshold for this reaction is about 600 MeV, and the effective cross section is 1.0 millibarn at 1000 MeV and higher energies. At these energies the effect of the coulomb barrier can be neglected. The angular distribution of secondary, high-energy nucleons generated by 70 GeV protons on a thin aluminum target was determined by means of gold foils. The detectors were placed in the plane of the equilibrium orbit of the protons at various angles from 5 to 55° and at various distances from the target. A comparison of the calculated and experimental data shows good agreement. The minimal, measurable flux of high-energy particles was 10^5 nucleons/cm^2-sec. (TTT)

44266 SOME RULES FOR CHOOSING A LIQUID SCINTILLATOR FOR IMPROVING THE COUNTING OF WEAK β EMITTERS.

Germai, G. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 39: 71-4 (1970). (In French).

To improve the counting of low β activities, it is important that the inhibition constant of the sample, measured for the scintillation solution to which it is added, be as small as possible. It is also necessary to increase the concentration of the first solution which makes the counting efficiency maximal when the scintillator contains a sample inhibitor. A rule is formulated which determines this increase. Finally, it is advantageous to add to the scintillator the largest possible quantity of naphthalene. (tr-auth)

44267 MEASUREMENT OF INTENSITY OF LIGHT EMITTED BY LIQUID SCINTILLATORS. Germai, G. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 39: 75-84(1970). (In French).

The results provided by the various techniques of measurement described in the literature are compared. The comparison criteria are the values of the inhibition constant and its precision. This constant is measured for a given scintillator solution and an inhibitor. Under the conditions of the equipment set up for this work and at the moment of excitation of the solution by a β or γ source, only the calculation of the mean height of the pulse by an established relation constitutes a measuring technique for luminous intensities which is precise and reproducible. (tr-auth)

44268 DESCRIPTION AND USE OF THE WHOLE-BODY COUNTER AT THE TRICO NUCLEAR CENTRE. Roels, J.; Brisbois, P.; Pollak, H. (Centre Nucleaire TRICO, Kinshasa, Congo). pp 229-38 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The whole-body counter at the TRICO Nuclear Centre is a small-size facility (1.25 m^3) which employs a crystal measurement system (17.5 cm in diameter and 12 cm high); the patient is seated in a chair with fixed geometry. The main protection is provided by iron, the walls being 12 cm, the ceiling 12.5 cm and the floor 14.5 cm thick. The inside dimensions are 193 cm × 80 cm × 78 cm. Lead (0.3 cm) and copper (0.3 cm) are used as a means of secondary protection. The shielded entry door is hand-operated. The facility is used for monitoring radiation (contamination), checking on cesium-137 and studying potassium-40. The metabolism of iron after digestive absorption has been studied, and also the influence of a modifier (lactoferin). The problem of 100% activity (calibration of the system) is discussed. (auth)

44269 SCINTILLATION CAMERAS BASED ON NEW POSITION ARITHMETICS. Tanaka, E.; Hiramoto, T.; Nohara, N. (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Med.; 11: 542-7(Sep 1970).

Ideal arithmetics for position computers for Anger scintillation cameras are discussed with emphasis on the improvement of intrinsic spatial resolution. The delay line position computer of the time conversion method and the delay line position computer of the pulse stagger method are proposed. (W.H.K.)

44270 IN-CORE INSTRUMENTATION. Goodings, A. (Atomic Energy Establishment, Winfrith, Eng.); Schallop, B. Nucl. Eng. Int.; 15: 599-606(Jul-Aug 1970).

A technical survey is presented which includes a review of in-core neutron flux detectors for power reactors. The scope and limitations of the various types of detectors are described. A folding chart provides, in tabular form, the characteristics and properties of commercially available neutron detectors for flux scanning and in-core monitoring. Typical commercial systems and specifications used in activation flux scanning are also listed. The application of in-core instrumentation, particularly to water reactors, is discussed and some examples are presented of systems used in German reactors. (UK)

44271 MAGNETIC RECORDING OF NEUTRON CROSS-SECTION DATA FROM AN UNDERGROUND NUCLEAR EXPLOSIVE SOURCE. Furnish, A. P. (Los Alamos Scientific Lab., N. Mex.); Arlowe, H. D. Contracts W-7405-eng-36; AT(29-1)-789. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; 17: No. 2, 3-6(Apr 1970).

A high-resolution magnetic data recording system has been successfully used as part of the Los Alamos program of time-of-flight neutron cross-section measurements that use an underground nuclear explosion source. The data received were recorded in frequency modulation form on a rotating hard-surfaced magnetic disc. This is a novel way of recording these data. Magnetic recording facilitates electronic digitizing of the data, since there is no need for time-consuming film reading. (auth)

44272 THE DETERMINATION OF FAST NEUTRON FLUX DENSITIES BY THE THRESHOLD DETECTORS ^{237}Np, ^{232}Th, ^{58}Ni, AND ^{27}Al. Koehler, W. (International Atomic Energy Agency, Vienna). Atomkernenergie; 15: 263-7(1970).

The threshold detectors ^{237}Np, ^{232}Th, ^{58}Ni and ^{27}Al were irradiated in three positions of two reactors. The reaction rates were determined from the produced radionuclides ^{140}Ba (in the two fission reactions), ^{58}Co, and ^{24}Na measured by a calibrated gamma spectrometer. Group flux densities were calculated assuming the differential flux density in the first group (0.1 MeV to 1.5 MeV) and in the second group (1.5 MeV to 3.0 MeV) to be constant with neutron energy, and in the third group (above 3 MeV) to be proportional to $\exp(-\beta E)$. The experimental results are in reasonable agreement with the calculations of French and Eggen and of Brousse for similar reactor positions. (auth)

44273 DETERMINATION OF WEAK BETA EMITTERS BY LIQUID SCINTILLATION COUNTING TECHNICS. III. INVESTIGATION OF ORGANIC CRYSTAL AND PLASTIC FLOW CHAMBER DETECTORS. Toeroek, G.; Parlagh, G.; Nagy, L. G. (Tech. Univ., Budapest). Period. Polytech. Chem. Eng.; 3: 249-60(1969).

The possibilities of the direct measurement of the activity of weak beta-emitter isotopes (C-14, S-35) in aqueous solution have been studied. Detectors were to be found, with which sulfite ions or free sulfurous acid do not interfere. Detectors of two types were studied in detail. One of them was a polyethylene tube bent helically, and filled with anthracene powder, the other was a plastic scintillator capillary, also wound spirally. The advantages of the first type are its high sensitivity (20 to 40 percent efficiency), the ease of preparing it in any laboratory, and the fact that its use does not require any special auxiliary equipment. Though of considerably lower efficiency (5 to 10 percent), the second type, owing to its reliability and easy handling, can be used more generally, but it is more exacting concerning apparatus. Both of the detectors can be used either for the determination of the activity of single samples, or for radiochromatogram recording. (auth)

44274 IMPROVEMENT IN PARTICLE TRACK ETCHING IN LEXAN POLYCARBONATE FILM. Peterson, D. D. (General Electric Research and Development Center, Schenectady, N. Y.). Rev. Sci. Instrum.; 41: 1252-3(Aug 1970).

An improvement in the process of particle track etching in Lexan polycarbonate film has been made leading to smoother track profiles. The improvement is based on the findings that, in aqueous sodium hydroxide, the bulk etching rate increases with an increase in the concentration of etch products in solution. The bulk etching rate as a function of etch product concentration is graphed. (W.H.K.)

44275 PROTECTIVE ALARM FOR LITHIUM DRIFTED GERMANIUM DETECTORS. Pohl, P. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Rev. Sci. Instrum.; 41: 1253-4(Aug 1970).

An alarm circuit for warning against excess leakage current in a lithium-drifted semiconductor detector due to inherent detector failure, vacuum failure, or cooling failure is described. (W.H.K.)

44276 RE-DETERMINATION OF THE Ra-α-Be NEUTRON SPECTRUM. Alvar, K. R.; Peck, R. A. Jr. (Brown Univ., Providence). Nucl. Instrum. Methods; 84: 195-8(1970).

A determination free of the distortions arising from lead gamma-shielding has been made, using CsI(Tl) as spectrometer of protons from a polyethylene radiator in coincidence with two gas proportional counters. Gamma response was completely suppressed by the combination of coincidence selection and pulse height discrimination. The spectrum shape matches that computed from contributing cross sections, an agreement which includes a larger rising slope than has previously been observed. Structure above the main peak is identifiable with (α,n) transitions to the 4.43-MeV state in ^{12}C. Comparison of the spectrum integral with moderated thick-target yields indicates that the low-energy contributions of $^{9}Be(\alpha,n)3\alpha$ and photo-neutrons (not measured in this experiment) constitute 30% of the entire spectrum, in agreement with the a priori estimate. (auth)

44277 DOUBLE SCATTERING PROTON POLARIMETER WITH HIGH RESOLUTION AND GOOD EFFICIENCY. Martin, J. P.; Levesque, R. J. A. (Univ. of Montreal). Nucl. Instrum. Methods; 84: 211-17(1970).

A double scattering proton polarimeter, using a silicon detector as the analyzer was designed and constructed. The detector provides means of measuring proton energy loss in the second scattering target, and energy of the recoil nucleus. Very thick analyzers, and large solid angles (0.3 str) can thus be used without

degrading energy resolution. At 10.5 MeV, efficiency is comparable to a 5 mg/cm^2 carbon foil polarimeter with the same solid angles, and energy resolution of 100 keV is typical. Analyzing power has a maximum value of 50% at 10.5 MeV, and varies quite smoothly with energy. (auth)

44278 VERSATILE COINCIDENCE UNIT WITH AUTOMATIC RANDOM COINCIDENCES SUBTRACTION. Cho, Z. H.; Baeverstam, U.; Othaz, R. (Univ. of Stockholm). Nucl. Instrum. Methods; 84: 321-4(1970).

A simple and versatile coincidence unit with automatic random coincidence subtraction useful for coincidence spectrometry is described. Simultaneously identified total and random coincidences are processed in the cascaded bistable gates (queuing circuits) and the results—true coincidences—are obtained. The circuit is constructed with E^{2}CL IC's and tunnel diodes. Thus high speed operation is achieved. The performance of the circuit is demonstrated by measuring the 121 keV(e_K) – 280 keV(γ) and the 165 keV(e_L) – 134 keV(γ) angular correlations in ^{75}Se and ^{197m}Hg respectively, and the electron spectrum in coincidence with the unresolved-NaI(Tl) scintillation detector-265 keV and 280 keV gamma rays in ^{75}Se. (auth)

44279 POSSIBLE EFFECTS OF PHOTOMULTIPLIER-AFTERPULSES ON SCINTILLATION COUNTER MEASUREMENTS. Staubert, R.; Boehm, E.; Hein, K.; Sauerland, K.; Truemper, J. (Univ., Kiel). Nucl. Instrum. Methods; 84: 297-300(1970).

Photomultiplier-afterpulses can lead to serious errors when measuring particle numbers with scintillator-photomultiplier systems employing pulse-height-to-time converters. The effectiveness of a dynode gating system restraining afterpulse effects is demonstrated through tests with a nanosecond light source on samples of several types of photomultiplier tubes. (auth)

44280 DEVELOPMENT OF PARALLEL PLATE CHANNEL MULTIPLIERS FOR USE IN ELECTRON SPECTROSCOPY. Nilsson, Oe.; Hasselgren, L.; Siegbahn, K.; Berg, S.; Andersson, L. P.; Tove, P. A. (Univ. of Uppsala). Nucl. Instrum. Methods; 84: 301-6(1970).

A simple method for designing parallel plate electron multipliers is described. Semiconducting and secondary emitting layers are deposited onto glassplates by rf-sputtering, and by placing two plates face to face with a separation of 0.6 mm a parallel plate multiplier is formed. The multipliers have a high gain (>10^6) and give output pulses with a very narrow pulse height distribution. The multipliers are used as detectors in electron spectrometers. The small dimensions imply that a large number of multipliers may be placed in the focal plane and used simultaneously. (auth)

44281 RESPONSE FUNCTION OF PROPORTIONAL COUNTER FOR SOFT X RADIATION. Hink, W.; Scheit, A. N.; Ziegler, A. (Univ., Wuerzburg, Ger.). Nucl. Instrum. Methods; 84: 244-52(1970). (In German).

At present no physical model is available to calculate the response function of the proportional counter. Five appropriate functions are therefore selected to fit the measured pulse height distributions of monochromatic X-rays. A function reported by Prescott for the response function of the scintillation counter gives the best result down to the C–K-radiation. The number G (= Gütezahl) introduced to test the quality of fit lies within the 96%-confidence-interval for this function. The construction and operation of the proportional counter is briefly described. Its energy resolution is somewhat inferior to the best reported value. Below about 1 keV the counter deviates from the generally assumed energy proportional behaviour. The reason for this deviation is that with decreasing X-ray energy increasing amounts of energy are absorbed per ion pair. (auth)

44282 PROPERTIES OF A PLASTIC–NaI(Tl) SUM COUNTER ARRANGEMENT FOR TIME AND ENERGY MEASUREMENTS. Bengtson, B.; Moszynski, M. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 85: 133-6(1 Aug 1970).

The geometrical arrangement is discussed—from the point of view of efficiency and ideal to nonideal scattering—for a plastic and a NaI(Tl) scintillation counter which are combined in such a way that the excellent timing properties of scintillating plastic are utilized together with the good energy resolution of NaI(Tl). A NaI(Tl) detector is used to absorb the Compton scattered γ-ray escaping from the scintillating plastic. Energy spectra resulting from summing of coincident events absorbed by the two detectors show excellent resolved full energy peaks. For the 662 keV γ-ray from ^{137}Cs the resolution is 10.5%. The energy resolution and the efficiency for various energies are studied. Application of the summing counters for identification of a delayed radiation is presented by a measurement of the 0.69 ns half-life in ^{125}Te. (auth)

44283 SIDE EFFICIENCY OF THE CHANNEL MULTIPLIER FOR 50 MeV PROTONS. Andresen, R. D.; Page, D. E. (European Space Research and Tech. Centre, Noordwijk, Netherlands). Nucl. Instrum. Methods; 85: 137-9(1 Aug 1970).

The ability of a channel multiplier to record radiation incident through its side walls has been studied using 50 MeV protons at the cyclotron of the Institute for Nuclear Research (IKO), Amsterdam. The results indicate that about 25% of the total length nearest to the low potential open end of a curved channel multiplier is sensitive to this radiation. (auth)

44284 ION FEEDBACK IN A STRAIGHT CHANNEL MULTIPLIER. Andresen, R. D.; Page, D. E. (European Space Research and Tech., Centre, Noordwijk, Netherlands). Nucl. Instrum. Methods; 85: 141-2(1 Aug 1970).

Experimental results are presented demonstrating by direct measurement the existence of positively charged particles produced within straight channel multipliers. These ions control the electron multiplication process of such detectors. (auth)

44285 MONOENERGETIC 6130-keV GAMMA-RAY SOURCE FOR DETECTOR CALIBRATION. Dickens, J. K.; Baybarz, R. D. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 85: 143-5(1 Aug 1970).

A monoenergetic 6130-keV gamma-ray source based upon the reaction ^{13}C(α,n)^{16}O has been fabricated using ^{244}Cm as the alpha source. (auth)

44286 MEASUREMENT OF THE EFFICIENCY OF A ^{6}Li GLASS SCINTILLATOR BY THE ASSOCIATED PARTICLE METHOD FOR NEUTRONS FROM 100 TO 500 keV. Fort, E.; Leroy, J. L.; Marquette, J. P. (CEA, Cadarache, France). Nucl. Instrum. Methods; 85: 115-23(1 Aug 1970). (In French).

The purpose of this experiment is to calibrate accurately some scintillators used to measure neutron fluxes in cross section determinations. ^{3}He particles from T(p,n)^{3}He reaction are detected at 10° from the proton beam. The backing of the titanium–tritium target is thin enough to let the beam through. The glass scintillator is placed in such a way as to intercept all neutrons associated with the detected ^{3}He particles. Coincidences between detected neutrons and ^{3}He particles are registered, and the total number of ^{3}He particles as well. The detector efficiency is in principle equal to the ratio of these two numbers. An analyser combining electrical and magnetic fields is used to separate ^{3}He particles from the tremendous rate of protons scattered from the target. A few minor corrections are needed to account for multiple scattering of ^{3}He particles in the target, and for multiple scattering of neutrons in the glass scintillator. An overall accuracy of 2.5 to 3% is achieved. The same neutron flux has been measured with this calibrated device, and with a proton recoil proportional counter. Both results agree within experimental errors. (auth)

44287 STUDY ON THE CONVERGENCE POINT FOR GAMMA-RAY IN A DIELECTRIC LIQUID IONIZATION CHAMBER. Nakayama, T.; Kawano, M. (Nagoya Univ., Japan). Nucl. Instrum. Methods; 85: 77-80(1 Aug 1970).

The characteristic of a parallel plate ionization chamber filled with dielectric liquid had been studied. The liquids used for measurement were n-hexane, cyclohexane, carbon tetrachloride and others. The ionization current was measured at various electrode spacings and for various radiation intensities. The experimental results obtained show that the abscissa of the convergence point for gamma-ray seems to be proportional to the linear energy transfer (LET$_\infty$), and is independent of the radiation intensity and the electrode spacing. (auth)

44288 OPTIMIZING THE SIGNAL-TO-NOISE RATIO OF TWO-STATE EXPERIMENTS. Bowman, J. D.; Vanderleeden, J. C. (California, Inst. of Tech., Pasadena). Nucl. Instrum. Methods; 85: 19-27(1 Aug 1970).

It is shown that in a two-state experiment of total duration $\overline{T}$, false asymmetries due to drifts with frequencies smaller than $\approx 1/\overline{T}$ can largely be eliminated by switching the state of the experiment in a sequence of unequal time intervals with average duration $\bar{t}$. In this frequency range this technique is greatly superior to the conventional method of switching at equal intervals $\bar{t}$, while both methods are about equally insensitive to drifts with frequencies larger than $\approx 1/\overline{T}$. This result is applied to the design of an experiment in which asymmetries on the order of 10^{-7} to 10^{-8} are measured. The optimum switching pattern consisting of unequal time intervals is calculated, and the conditions for its use are discussed. Comparison with a conventional switching pattern shows that effects of slow drifts can be lowered by sev-

eral orders of magnitude in most cases of practical interest. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 45655.

44289 (AECL-3563) A HIGH RESOLUTION, BROAD RANGE SPECTROMETER FOR THE MP TANDEM. Milton, J. C. D.; Ball, G. C.; Davies, W. G.; Ferguson, A. J.; Fraser, J. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1970. 35p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

It is proposed to obtain a high resolution ($\Delta E/E \sim 5000$), high dispersion (12,800 $\Delta p/p$ mm), large solid angle (15 msr), broad range ($E_{max}/E_{min} = 1.5$), magnetic spectrometer for use in the MP Tandem accelerator laboratory. Experiments that require, or would benefit from, such a device are discussed, as are the considerations leading to the choice of a magnetic spectrometer. A brief description of the instrument and the effect of the design aims on its configuration and parameters is given. When equipped with a multiwire proportional (Charpak) counter the spectrometer is ideally suited for high resolution coincidence experiments as well as for "classical" charged particle spectroscopy. (auth)

44290 (CONF-691101-, pp 537-51) NEUTRON SPECTROMETER PERFORMANCE AT 14 MeV. Osborn, David H.; Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Physics).

The performance of a time-of-flight spectrometer for neutrons from 10 to 100 MeV was studied with 14 MeV neutrons from the neutron generator facility at the National Research Council, Ottawa, Canada. The first detector is a 2″d × 2″h NE-213 liquid scintillator; the second detector is a 5″d × 4″h NE-102 plastic scintillator. Both scintillators are mounted on Amperex 58 AVP photomultipliers. The mean flight path between the detectors was 2.43 meters. The time dispersion of the electronic system is 1.7 ± 0.3 nanoseconds (fwhm) as observed from the time-of-flight spectrum of gamma rays. The pulse-shape discrimination circuitry gave a peak-to-valley ratio of 11 for neutron- and gamma-induced pulses with a pulse-height equivalent to that of a recoil proton between 1.5 and 2.0 MeV. The energy resolution for 14 MeV neutrons is about 7 percent with this geometry and with this recoil proton energy interval. The counting rate of neutrons was measured as a function of the position and the magnitude of the recoil proton kinetic energy interval. The counting rate falls off as the position of the proton energy interval varies from that needed to satisfy kinematics. The counting rates are in agreement with expected counting rates. (auth)

44291 (CONF-691101-, pp 552-65) STRAY NEUTRON SPECTRA AND COMPARISON OF MEASUREMENTS WITH DISCRETE ORDINATES CALCULATIONS. Holeman, G. R.; Shaw, D. McM.; Price, K. W. (Yale Univ., New Haven, Conn.).

Neutron energy spectra were obtained near the Yale M.P. Tandem Van de Graaff Accelerator during a series of scattering experiments. Spectral measurements were performed using a Bonner Spectrometer with 2, 3, 5, 8, 10 and 12 inch spheres with protons and deuterons as the accelerated particles. Neutron spectra were measured for various beam currents for a given energy and projectile. Extensive data were accumulated at one location near the target area and this information is presented in such a form as to allow for the determination of spectra and dose equivalent by knowing various machine parameters. A set of shielded and unshielded spectra was measured. The unshielded spectrum was used as input to a discrete ordinates neutron transport calculation using ANISN. The shield was a 91 cm thick concrete slab with a nominal density of 2.39 gm/cm^3 with a 2.96 mg/cm^3 of borax loading. Calculations were performed for several energy groupings. The concrete was simulated by several mixtures of materials. A comparison of the theoretical calculations and measurements is presented. Limitations and difficulties in obtaining the measured spectra are presented in addition to a discussion of the theoretical results and the many factors influencing the results. (auth)

44292 (CONF-691101-, pp 566-85) NEUTRON SPECTRUM AT THE HENRE ACCELERATOR. Barrall, R. C.; Holmes, J. A.; Silbergeld, M. (Stanford Univ., Calif.).

Foil radioactivation techniques were applied to the measurement of the neutron spectrum generated by the $^3H(d,n)^4He$ reaction at the High Energy Neutron Reaction Experiment (HENRE) accelerator located at the AEC's Nevada Test Site. Two neutron spectra were studied: (1) Thirty-seven feet from the target and 11 inches from the ground; (2) one meter from the target, approximately 24 feet from the ground. Thirty-one reactions were measured and the spectra were calculated using the Spectrum Analysis by Neutron Detectors II (SAND II) computer code. The data obtained from the one meter run were used to aid in evaluation of conflicting cross section measurements found in the literature. The results obtained lend confidence to further application of foil radioactivation techniques for the measurement of neutron flux density and fluence in other less well known accelerator spectra. (auth)

44293 (NP-18356) A Ge(Li)-Ge(Li) SUM-PEAK (SUMMING COINCIDENCE) SPECTROMETER. Kantele, J.; Suominen, P. (Jyvaskyla Univ. (Finland). Dept. of Physics). Apr 1970. 33p. Dep. CFSTI (U. S. Sales Only).

The sum-peak spectrometer (also called the integral-bias summing coincidence spectrometer) arrangement earlier developed with NaI(Tl) detectors is extended to Ge(Li) detectors. The integral-bias method in sorting sums of coincident pulse amplitudes is replaced by a set of pulse-height selection windows, which simply and more effectively aid in the analysis of sum-peak complexities associated with the symmetric linear summing procedure employed. A large part of the original information lost in summing of the pulse amplitudes can be retained by simultaneous sorting of the total spectrum into suitable subgroups. The arrangement represents in effect a real-time totalizing spectrometer having a limited memory capacity. A good running-time economy is achieved at the expense of advance and subsequent computer analysis. A high-efficiency geometry with virtually no crystal-to-crystal scattering is introduced. The performance of the new spectrometer system is demonstrated and discussed. (auth)

44294 (RT/EL-(69)12) CONTROL SYSTEM WITH LINEAR CALCULATOR FOR EXPERIMENTS IN NEUTRON SPECTROMETRY. Babiloni, L.; de Agostino, E.; Fillarini, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 12 Nov 1969. 19p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Software and hardware for a PDP-8 controlled triple axis neutron diffractometer are outlined. (auth)

44295 (RT/EL-(70)1) INTERFACE FOR PDP-8L COMPUTER CONTROL OF A TRIPLE-AXIS NEUTRON SPECTROMETER. Babiloni, L.; de Agostino, E.; Fillarini, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Dec 1969. 26p. (In Italian). Dep. CFSTI (U. S. Sales Only).

In this report the interface for a PDP-8L computer control of a triple axis neutron spectrometer is described. (auth)

44296 (RT/EL-(70)2) SOFTWARE FOR PDP-8L ON-LINE CONTROLLED TRIPLE-AXIS SPECTROMETER. Babiloni, L.; de Agostino, E.; Fillarini, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 17 Feb 1970. 36p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The software for a PDP8-L controlled triple axis diffractometer is described. A detail description is given of the programs for the data acquisition and the on-line control. (auth)

44297 USE OF SEMICONDUCTOR DETECTORS FOR THE RADIOISOTOPIC X-RAY FLUORESCENCE METHOD. Fedorov, A. A.; Ochkur, A. P.; Mitov, V. N.; Yanshevskii, Yu. P. At. Energ. (USSR); 28: 428-9(May 1970). (In Russian).

The low sensitivity of the scintillation and proportional counters used for recording x-ray spectra by the radioisotopic x-ray fluorescence method makes it difficult to determine elements with close atomic numbers. The efficiency of the method may be considerably improved by using high-resolution semiconductor detectors. Secondary x-ray K spectra were measured in a thick layer of various mercury concentrations by such instruments, using alabaster as filler. A 10-mCie, ^{75}Se source was used to excite the characteristic x radiation of mercury, recording the secondary spectra by means of a germanium-lithium semiconductor detector with a 4.0 keV resolution of the 123-keV γ line of a ^{57}Co source. The resolution of the detector was sufficiently high to allow a clear cut identification of the K_α and K_β lines of the characteristic x-ray spectrum of mercury and of the scattered γ radiation corresponding to the γ lines of the ^{75}Se source. The signal/background ratio in the range of the K_α emission of mercury was five times higher than was found possible with scintillation counters. (TTT)

44298 DETERMINATION OF THE INITIAL COUNTING RATE IN GAMMA-SPECTRUM MEASUREMENTS OF SHORT-LIVED ISOTOPES ON A MULTICHANNEL ANALYZER. Mednis, I. V.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 1, 3-8(1970). (In Russian).

A method has been developed for determining the initial count-

ing rate of short lived isotopes during the live time of a multichannel analyzer. The relationships between the time intervals, the registered number of pulses and the initial counting rate have been established considering the decreasing activity of the isotope during the measurements and the blocking of the analyzer input at high counting rates. (auth)

44299 SIMPLE MYLAR WINDOW HELIUM CRYOSTAT FOR MOESSBAUER MEASUREMENTS. Zabransky, B. J.; Ruby, S. L. (Argonne National Lab., Ill.). Rev. Sci. Instrum.; 41: 1359-60 (Sep 1970).

The design of a simple glass helium cryostat with Mylar windows for a gamma source for Moessbauer studies is described. (W.H.K.)

44300 Ge(Li) RADIATION DETECTORS. Harry, R. J. S. Atoomenergie Haar Toepass.; 12: 147-53; 156-64(May 1970). (In Dutch).

The resolution of detectors based on NaI(Tl), Si(Li), and Ge(Li) crystals and the effect of impurities on their performance are examined. The detectors are cooled with liquid nitrogen to prevent redistribution within the crystal. The influence of the photoelectric, and Compton effects and pair formation on the process of γ detection is examined. The excellent resolution, linearity and stability of Ge(Li) detectors make it imperative to use only the best electronic circuits and components, such as pre-amplifier, amplifier and pulse-height analyzer systems. The effect of collimation, incidence and source radiation on the formation of the spectrum is graphically illustrated. The decay and the distribution of the decay products of the HFR fuel elements are measured by means of a homogeneous detector, a pinhole camera, with a small image with respect to the diameter of the detector. The high efficiency and excellent resolution have made it necessary to use Ge(Li) detectors for activation analyses and for the study of n,γ reactions. (TTT)

44301 SIMPLE METHOD FOR FULL AUTOMATIC GAMMA-RAY SPECTRA ANALYSIS. Slavic, I. A.; Bingulac, S. P. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Nucl. Instrum. Methods; 84: 261-8(1970).

A method for full automatic gamma-ray spectra analysis is described. The method includes a simple procedure for peak finding by comparing the successive values of experimental data as well as fitting by the least square technique. Assuming that some high peaks which are singlets can be found in both halves of the spectrum being analyzed, two of these peaks could be taken and a straight line determined, this representing approximately the dependence of fwhm of singlets on the channel number. This is the base for a automatic resolving of composite peaks. According to the method described, a FORTRAN program has been realized and an example showing its application to a spectrum analysis is given. The examples of a few fitted doublets in composite peaks with the differences in positions of about $^3/_4$ of the fwhm value are separately indicated. For some of them a comparison is given showing that these doublets cannot be resolved if analyzed by one of the methods used up to now, and the results appear as "singlets" of fwhm of anomalous values. Since the peak finding method described here does not assume any mathematical form of the spectrum analysed, it can be applied more widely to other cases of automatic analysis in similar distributions. (auth)

44302 SPECTRUM MEASUREMENTS OF INTERMEDIATE ENERGY NEUTRONS BY AN ORGANIC SCINTILLATOR. Furuta, Y.; Kinbara, S.; Kaieda, K. (Japan Atomic Energy Research Inst., Tokai). Nucl. Instrum. Methods; 84: 269-74(1970).

The pulse height distribution was obtained experimentally for monoenergetic neutrons having energies from 566 keV to 52 keV with a newly developed gamma-ray pulse shape discriminator, the risetime to pulse height converter (RHC), in conjunction with an NE-213 scintillator. The gamma-ray rejection and the discrimination loss of 52 keV neutrons were estimated to be 99.4% and 13%, respectively, and the estimated neutron energy corresponding to the cut-off of the pulse height distribution was 20 keV. The light outputs of the NE-213 scintillator for neutrons (protons) to the energies are also shown in ^{60}Co light units. (auth)

44303 GERMANIUM SURFACE BARRIER DETECTOR WITH DEEP DEPLETION LAYER FOR γ-RAYS. Tavendale, A. J. Australian Atomic Energy Commission, Lucas Heights). Nucl. Instrum. Methods; 84: 314-16(1970).

Gamma-ray spectrometer and diode characteristics are given for a 2 mm-depletion layer, gold surface-barrier detector, constructed from ultra-high purity n-type germanium. (auth)

44304 SIMPLE VELOCITY SWEEP MOESSBAUER DRIVE. Tamul, J. J.; York, L. A.; Seykora, E. J. (East Carolina Univ., Greenville, N. C.). Nucl. Instrum. Methods; 84: 317-20(1970).

An easily constructed velocity sweep Moessbauer spectrometer system is described which minimizes the problems associated with electronic feedback mechanisms. The drive is inexpensive and is constructed from commonly available materials. (auth)

44305 STATISTICAL CONSIDERATIONS IN HALF-LIFE MEASUREMENT. III. Jaffey, A. H. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 84: 218-36(1970).

This paper is a continuation of two earlier papers, in which certain factors affecting the statistical error in half-life estimation were examined from a statistical viewpoint. In this paper we consider: (1) a correlation effect with few counting intervals, (2) a correlation effect due to use of a single background measurement for an entire decay curve, (3) efficient pooling methods for the results of multiple experiments, (4) optimum choice of truncation time when multiple samples are used, (5) half-life estimation in multicomponent systems, and (6) the effect of non-Poisson count distributions when genetically-related species are counted. (auth)

44306 COMPTON RECOIL GAMMA-RAY SPECTROSCOPY. Gold, R. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 84: 173-94(1970).

A method of continuous gamma-ray spectroscopy based on Compton electron continuum measurements has been developed. Recoil electron energy spectra are observed in lithium-drifted silicon solid-state detectors. Iterative unfolding is used to determine the gamma-ray continuum from the observed electron recoil energy distribution. Limitations of the method are discussed. Absolute measurements in the energy region 0.2 to 2 MeV are possible with an accuracy of approximately 20%. In-core gamma continua observed in a depleted uranium Snell block, a graphite thermal column, and a fast reactor critical assembly are presented. (auth)

44307 AN INSTRUMENT FOR AUTOMATIC CORRECTION FROM THE BACKGROUND DUE TO UNCORRELATED EVENTS IN NUCLEAR PULSE SPECTROMETRY. Cova, S.; Bertolaccini, M. (Politecnico, Milan). Rev. Sci. Instrum.; 41: 1153-60(Aug 1970).

For measurements of the statistical distribution of parameters of pulses (peak amplitude, etc.), a technique is introduced to measure accurately the background due to pulses not correlated in time to the events of interest. This technique is applicable when an event marker signal, correlated in time to the events of interest, is available, i.e., always in time measurements and often in other cases. The basic principle is to make cycles of two successive measurements, in which the probability of measuring a background pulse is the same for both, while the one of measuring an event pulse is much higher in the first measurement; the results of the two measurements must be treated differently. The technique and its applications to amplitude and time measurements are considered in detail. The instrument developed is presented together with some experimental results. (auth)

44308 VERSATILE DATA ACQUISITION SYSTEM FOR GENERAL GAMMA RAY SPECTROSCOPY. Hirko, R. G.; Lindgren, R. A.; Howard, A. J.; Pronko, J. G.; Sachs, M. W.; Bromley, D. A. (Yale Univ., New Haven). Nucl. Instrum. Methods; 85: 1-18(1 Aug 1970).

A description is given of the associated hardware and instrumentation which have been designed and adapted for use in general gamma-ray spectroscopy studies involving nuclear reactions where high bombarding energies, typically available from tandem electrostatic accelerators, are employed. The function of the system is illustrated by experimental data taken from recent particle-gamma-ray angular correlation and Doppler shift lifetime measurements involving utilization of the laboratory on-line IBM 360/44 data acquisition system. (auth)

44309 NEW TYPE OF DOUBLE-FOCUSING MAGNETIC SPECTROMETER. Wohn, F. K. (Iowa State Univ., Ames); Wilkinson, R. G. Nucl. Instrum. Methods; 85: 33-43(1 Aug 1970).

A double-focusing magnetic spectrometer was built for beta-gamma angular correlation studies. The magnetic field was obtained by double wedge shaped iron polefaces. The resulting electron trajectories are trochoidal in nature, and the central trajectory covers an angular range of approximately $\pi\sqrt{2}$ rad. Numerical calculations of the focusing properties indicate that the magnetic field gives first-order double-focusing that is very similar to the $\pi\sqrt{2}$ first-order double-focusing principle. (auth)

44310 COMPUTER CODE FOR CALCULATION OF ABSOLUTE AREAS OF OVERLAPPING PEAKS IN ENERGY SPECTRA. de Castro Faria, N. V.; Martin, J. P.; Levesque, R. J. A. (Univ. of Montreal). Nucl. Instrum. Methods; 85: 49-52(1 Aug 1970).

A computer code was developed for the calculation of absolute areas in the special case of a very small peak with poor statistics overlapping the tail of a large one. It is also useful in general cases, as long as the area includes a reasonable number of channels; the simplicity of the method makes it very naturally adaptable to light pen work. It does not make use of an analytical form for fitting, but of actual experimental points taken from a selected portion of the larger peak. Its accuracy was tested by analysing the spectra constructed artificially from the addition of two different peaks and background of exactly known individual areas. The values obtained with the computer code were in agreement with the actual areas within 10% in the worst case (peaks with 10^3 and 10^5 counts separated by their width at half maximum). In normal cases, this agreement can be as good as 0.1%. The peaks are assumed to have the same shape. (auth)

44311 COMPARISON OF FOLDING AND UNFOLDING TECHNIQUES FOR DETERMINING THE GAMMA SPECTRUM FROM THERMAL NEUTRON CAPTURE IN ALUMINUM. Booth, R. S. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 85: 69-76(1 Aug 1970).

The gamma-ray spectrum above 1 MeV resulting from thermal-neutron capture in aluminum is determined by both a folding and an unfolding analysis of data taken at the Tower Shielding Facility. This results in a comparison of the relative merits of the two analysis techniques and demonstrates the accuracy that can be obtained in unfolding a complex spectrum. It is concluded that the accuracy of the final photon spectrum is not governed by the technique employed to unfold the measured counts. (auth)

High Energy Physics Instrumentation

44312 (CERN-70-19) A SYSTEM OF FILM-PLANE DIGITIZERS ON-LINE TO A CDC 3100 COMPUTER. Fucci, A.; Mazzari, C.; Tausch, L.; Verkerk, C. (European Organization for Nuclear Research, Geneva (Switzerland)). 9 Jul 1970. 24p. Dep. CFSTI (U. S. Sales Only).

The on-line film plane digitizing system used at CERN for measuring bubble chamber film is described. Six measuring devices are connected on-line to a CDC 3100 computer. Both the hardware and software are discussed, and operation and performance are reviewed. (W.H.K.)

44313 (COO-1428-209) STATUS AND PERFORMANCE OF THE PURDUE SMP MEASURING SYSTEM. McIlwain, R. L.; Loeffler, F. J.; Palfrey, T. R. Jr. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [nd]. 9p. (CONF-700323-2). Dep. CFSTI.

From 10th International Conference on Data Handling Systems in High Energy Physics, Cambridge, England.

The time-sharing measuring facility consists of 5 SMP's and 2 NRI film-plane microscopes coupled to an IBM 360/40 through a multiplex channel. The 360/40, having only 8K 32-bit words, cannot hold full track-banks from the SMP's. It therefore stores track section buffers onto a 2311 disk file as they come in, until the SMP operator indicates end-of-data. Completed tracks (or fiducials) are then read into an IBM 360/44, where they are filtered. Smooth points are stored by the 360/44 on another 2311 disk workfile, track-view by track-view. The on-line geometry is evaluated, and the overall system performance is discussed. (W.H.K.)

44314 (IFVE-SEF-69-32) A SCANNING-MEASURING TABLE FOR HANDLING FILMS FROM BUBBLE CHAMBERS AND OSCILLOGRAMS. Zhil'chenkova, G. D.; Karlov, G. D.; Longinov, V. D.; Popov, M. I.; Buyanov, V. P.; Yablokov, A. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A scanning-measuring table with a bipolar coordinate measuring system is described. The work is usually carried out with a 35 mm perforated film. Scanning and measuring is carried out on the screen with a magnification of 20. The least count of each radius is 0.3 mm. (auth)

44315 (UR-875-315) IMPROVED RECONSTRUCTION OF HIGH MOMENTUM TRACKS USING A DOUBLE PRECISION VERSION OF TVGP. Katz, W. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Jul 1970. Contract AT(30-1)-875. 4p. Dep. CFSTI.

TVGP reconstruction of high momentum tracks using an IBM 360/65 computer is found to be sensitive to machine rounding errors. These rounding errors are significant for values of the momentum (in GeV/c) $\geq$ the length of the track (in cm). Conversion of TVGP into double precision gives excellent reconstruction results up to 1000 GeV/c. (auth)

44316 ON THE POSSIBILITY OF CREATING CONDITIONS OF PERMANENT SENSITIVITY OF SUPERCOOLED LIQUIDS TO CHARGED PARTICLES. Dronov, V. S. (Rostov State Univ., Rostov-on-Don, USSR). Zh. Eksp. Teor. Fiz.; 58: 1784-8 (May 1970). (In Russian).

The possibility of creating conditions of permanent sensitivity of supercooled liquids to charged particles by setting up a certain temperature gradient in the liquid is analyzed theoretically. Some theoretical demands on the geometrics of the system, choice of working liquid and material of the walls and top are established. Formulas are presented for estimating the upper and lower temperatures of the sensitivity zone. The width of the latter is determined. (auth)

44317 METHOD TO DETERMINE THE ISOTOPIC COMPOSITION OF COSMIC RAY CARBON. Joensson, G.; Kristiansson, K.; Malmqvist, L. (Univ. of Lund, Sweden). Nucl. Instrum. Methods; 84: 282-8(1970).

We describe a method to determine the isotopic composition of cosmic ray carbon. As a detector we have used nuclear emulsions which were exposed to the primary radiation in a high altitude balloon flight. The mass determinations are based on measurements of the relation between track width and residual range in the range interval $1 < R < 12$ mm. The track width has been measured with a nuclear track photometer. The standard deviation of the experimentally determined mass values of ^{12}C nuclei amounts to 2.9%. We conclude that the method described can be used for studies of the isotopic composition of carbon in the primary cosmic radiation. (auth)

44318 TRACK-FINDING IN EMULSION PLATES WITH THE AID OF HIGH RESOLUTION SPARK CHAMBERS. Dauber, P. M.; Smith, L. H.; Wahlig, M. A. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 84: 199-204(1970).

We have demonstrated that minimum ionizing tracks at near-normal incidence to an emulsion plate can be found rapidly and with near -100% efficiency with the aid of high resolution optical spark chambers. The mean distance between predicted and found track locations was 150 μm. The mean difference between angles predicted by the spark chambers and measured in the double-sided emulsion plate was 1.4 mrad. We discuss the implications of these results for use in emulsion-magnetic spectrographs with maximum detectable momenta greater than 10^4 GeV/c. (auth)

44319 DEVICE FOR THE MEASUREMENT OF IONIZATION DENSITY OF BUBBLE CHAMBER TRACKS. Jacobs, D. A.; Robinson, C. J. (Univ. of Glasgow). Nucl. Instrum. Methods; 84: 307-13(1970).

A scanning system and control hardware are described which measures the ionisation density of bubble chamber tracks. The device is attached to a conventional film plane digitizing measuring machine. (auth)

44320 DIGITIZED CO-ORDINATE RECORDING DEVICE FOR NUCLEAR TRACKS MEASURING INSTRUMENTS. Malaroda, R.; Zecchin, G. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nucl. Instrum. Methods; 84: 275-81 (1970).

A description is given of a co-ordinate digitizing recorder (WRD code) mounted on a standard microscope with precision micrometer stage, for nuclear plated investigation. The same equipment was also mounted on a manual film scanner of bubble chamber photograms, with very good results. (auth)

44321 MASS RESOLUTION IN INVESTIGATIONS OF THE ISOTOPIC COMPOSITION OF HEAVY ELEMENTS IN COSMIC RADIATION. Malmqvist, L. (Univ. of Lund, Sweden). Nucl. Instrum. Methods; 84: 289-92(1970).

This paper discusses the mass resolution which can be expected in mass measurements of cosmic ray particles stopping in a stack of nuclear emulsions. The mass determinations are based on accurate measurements of the relation between track width and residual range. The results show that it is possible to perform a mass measurement with a standard error less than 0.5 atomic mass units for nuclei in the charge interval $4 \leq Z \leq 12$ if a track length of about 10 mm is available for measurement. (auth)

44322 DETECTOR SYSTEM FOR COSMIC RAY ELECTRONS. Hovestadt, D.; Meyer, P.; Schmidt, P. J. (Univ. of Chicago). Nucl. Instrum. Methods; 85: 93-100(1 Aug 1970).

The construction, operation and calibration of a balloon-borne counter telescope is described. The instrument is designed for a measurement of cosmic ray electrons in the energy range from 15 MeV to 15 GeV. Results of calibrations on electron accelerators

for energies between 10 MeV and 6 GeV are compared with predictions from shower theory. The detector has an energy resolution between 20 and 40 percent for electrons and discriminates efficiently against protons. The geometry factor is 18 cm^2 sterad. (auth)

44323 HIGH RESOLUTION THRESHOLD CHERENKOV COUNTER. Denisov, S. P.; Donskov, S. V.; Dunaitsev, A. F.; Gorin, Yu. P.; Petrukhin, A. I.; Prokoshkin, Yu. D.; Shuvalov, R. S.; Stoyanova, D. A. (Inst. for High-Energy Physics, Serpukhov, USSR). Nucl. Instrum. Methods; 85: 101-7(1 Aug 1970).

This paper describes a 5 m gas Cherenkov threshold counter with a velocity resolution $\delta = 6.5 \times 10^{-6}$. Resolution of $\delta = 3.6 \times 10^{-6}$ has been achieved as the result of summarizing the signals from two counters. High velocity resolution has been obtained due to the effective registration of Cherenkov light in the short-wave region (counter spectral range: 1800–6000 Å). The threshold counter characteristics have been investigated in 5 to 60 GeV/c beams of the 70 GeV accelerator. The particle registration efficiency on the plateau is more than 99.99994%. The probability of the particle registration below the threshold is less than 3×10^{-4}. (auth)

Radiation Dosimeters

Refer also to abstracts 44173, 44243, 44245, 44247, 44357, 44482, 45645, and 45646.

44324 (BARC–460) PANORAMIC EXPOSURE ASSEMBLY. Rao, P. S.; Gupta, U. C. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 8p. Dep. CFSTI (U. S. Sales Only).

A panoramic exposure assembly is designed and fabricated for accurate intercomparisons and routine calibration of dosimeters. The assembly consists of three systems viz. a pneumatic source positioning system, exposure timing system and detector positioning system. A Ra source (9 mg), whose exposure rate has been determined with the exposure standards set-up, is used for the calibration of detectors. The exposure intervals can be preset from a few seconds to 9999 secs. A number of dosimeters can be clamped in an arc of 30 cms. radius at a height of 6 feet above the ground level. The system is safe, automatic and remotely controlled. It has a precision better than a fraction of a percent for intercomparisons and an accuracy better than ±3 percent for calibration of dosimeters. (auth)

44325 (BRH/DEP–70–21) EVALUATION OF AN X-RADIATION DOSIMETRY SERVICE FOR HOME TELEVISION RECEIVERS. Warr, Charles P. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Aug 1970. 18p. CFSTI.

An analysis and evaluation of the consumer oriented, television x-radiation thermoluminescent dosimetry system, Ray-Alert, was performed. Detailed attention was given to statistical analysis in order to specify the test conditions as rigidly as possible. The results are summarized, taking into account the capability of the dosimetry service and its application to the measurement of x radiation from television receivers. (auth)

44326 (CEA-N-1288) STUDY OF A NEUTRON DOSIMETER BASED ON ELECTRICAL RESISTIVITY CHANGES. TUNGSTEN DOSIMETER. Cance, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1970. 135p. (In French). Dep. CFSTI (U. S. Sales Only).

After a brief review of the main phenomena of creation of damage in metals, a study is made of the effect of in-pile neutron irradiation on the electrical resistivity of tungsten. The preparation of samples for irradiation and the technique of measurement, as well as the installation are described. A relationship is established between the measured effects ($\Delta R/R$) and the neutronic characteristics on the irradiation (fast, intermediate, and thermal fluxes). It is shown how in the region studied (irradiation temperature of under 100°C and ($\Delta R/R$) ≤ 5%) the method makes it possible to measure fluxes (tungsten equivalent fast flux). (auth)

44327 (CONF-691101–, pp 809-16) USE OF AN IONIZATION CHAMBER FILLED WITH A DIELECTRIC LIQUID FOR THE MEASUREMENT OF THE QUALITY FACTOR IN AN ALTUGLAS PHANTOM IRRADIATED BY A 3 BeV PROTON BEAM. Mathieu, Jacques; Blanc, Daniel; Casanovas, Joseph; Patau, Jean-Paul (Toulouse Univ. (France). Centre de Physique Atomique et Nucleaire).

For an applied electric field E, the intensity of which corresponds to the region where, in the dielectric liquid, the preferential columnar recombination plays a preponderant role, the slope of the characteristic I = f(E) of an ionization chamber with parallel plane electrodes is directly linked to the value of the linear energy transfer of the radiation which crosses it. The value of the abscissa of the intersection point, with the axis of the electric field, of the extrapolated part of the characteristic makes it possible to assess the quality factor of the radiation, which can be pure or complex. The results are valid in so far as the intensity of this radiation does not saturate the chamber response (delivered dose less than 30 Rads, with 0.2 second pulses). On that condition, our method enables us to measure the quality factor at different points of an Altuglas phantom irradiated by the 3 GeV beam of the SATURNE accelerator (Saclay) and by the scattered radiation. The ionization chamber used is made up of two Lucite disks, 11 cm in diameter. The electrodes are made of beryllium disks, or rings, 0.2 to 0.5 mm thick which define a sensitive volume 0.9 to 1 mm thick and 2 cm in diameter filled with a very pure hydrocarbon liquid (Trimethyl 2-2-4 pentane, $\rho > 10^{19}\ \Omega \times cm$). The chamber is put in an Altuglas phantom 20 cm in diameter and 32 cm long which is placed in a photon beam in different locations. (auth)

44328 (COO–1105–155) SUGGESTIONS FOR FAST NEUTRON DOSIMETER TECHNIQUES. Moran, P. R.; Podgorsak, E. B. (Wisconsin Univ., Madison. Dept. of Physics). [1969]. 12p. Dep. CFSTI.

Fast neutron interaction processes with matter are reviewed, and general considerations for neutron damage defect state detection are outlined. Neutron defect detection based on photoexcitation fluorescence, metastable exciton properties, photoconductivity, Raman scattering, and Rayleigh scattering is discussed. Ammonium salts, silver activated ammonium salts, cyctic hydrocarbons, and simple grouped organics are suggested as materials. (W.H.K.)

44329 (COO–1105–156) SUPRALINEARITY OF UV REPOPULATED TL FROM TLD-100. Pearson, D. W.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Physics). [1969]. 6p. Dep. CFSTI.

Samples of TLD-100 were irradiated with different exposures of cesium-137 gamma radiation, heated to 300°C, exposed to ultraviolet radiation, and the repopulated thermoluminescence curves measured. The repopulated thermoluminescence vs initial gamma exposure is plotted. A region of supralinear behavior is seen between 10^3 and 3×10^4 R. (W.H.K.)

44330 (COO–1105–157) NMR STUDIES FOR A DIFFUSION ACTIVATED MECHANISM IN TLD IN LiF. Wagner, Jerome; Moran, P. R. (Wisconsin Univ., Madison). [1969]. Contract AT(11-1)-1105. 3p. Dep. CFSTI.

Systematic NMR measurements were carried out over a wide temperature range in thermoluminescent lithium fluoride samples in an attempt to correlate the NMR properties and the body diffusion of defect states in lithium fluoride. It was concluded that there is no correlation between the NMR measured diffusion activation energies and the thermoluminescence activation energies. (W.H.K.)

44331 (EUR–4452, pp 137-52) FURTHER MEASUREMENTS OF LET SPECTRA WITH A 10 cm SPHERICAL ROSSI COUNTER. Wilson, K. S. J. (Hammersmith Hospital, London (England). Medical Physics Dept.); Field, S. B. (Medical Research Council, London (England). Cyclotron Unit).

LET spectra have been determined for several fast neutron beams produced by the Medical Research Council cyclotron at Hammersmith Hospital, for 14.6 MeV neutrons from the (d,t) generator at the Middlesex Hospital, and for scattered radiation at Nimrod, the 7 GeV proton synchrotron at the Rutherford High Energy Laboratory. In two cases, comparisons are made with theoretical spectra calculated by Bewley, showing excellent agreement. The effect of 10 cm of paraffin wax on the (d,n) cyclotron neutrons is shown to be small. (auth)

44332 (EUR–4452, pp 153-70) DOSE DISTRIBUTION IN SMALL TISSUE-EQUIVALENT VOLUMES. Srdoc, D. (Columbia Univ., New York).

An experimental technique for measuring the energy deposit distribution in small tissue-equivalent volumes using the Rossi counter is described. The counter design, calibration, and gas multiplication are discussed. Aluminum and carbon K-lines have been used for the energy calibration as well as for testing the counter resolution. Two tissue-equivalent gas mixtures, one containing methane and the other with propane have been investigated. The linearity of the counter response has been carefully checked down to 0.277 keV. No significant departure from the linear relationship between the energy and the mean pulse height has been observed at low gas gain which indicated a constant energy per ion pair ratio. A substantial reduction of the preamplifier noise has been achieved by incorporating the input stage of an FET

charge sensitive preamplifier into the counter base. An operational amplifier with the logarithmic characteristic has been included into electronics in order to convert the linear spectrum into the E(N)E vs log E spectrum. A number of energy deposit distribution has been measured corresponding to 2, 1, 0.5, 0.25, and 0.125 μm tissue sphere using an external source of ^{60}Co gamma radiation. (auth)

44333 (EUR-4452, pp 171-81) DISTRIBUTION OF ENERGY DEPOSITION BY γ-RAYS AND 15 MeV NEUTRONS IN CYLINDRICAL VOLUMES. Hogeweg, B.; Barendsen, G. W. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut).

Damage induced by ionizing radiations in biological systems is presumably caused by high local energy densities produced in one or more essential cellular structures of as yet unknown size and shape. In order to investigate the extent to which the shape of a structure is an important parameter with respect to the probability of the induction of damage by different radiations, measurements of event size spectra have been performed with two cylindrical proportional counters with a central wire for which the ratios of length and diameter were 10 and 2 respectively. Irradiations were carried out with ^{60}Co γ-rays and 15 MeV neutrons produced by the D–T reaction. At a pressure of 1000 Torr and 200 Torr of tissue-equivalent gas no differences were observed between the event size distributions measured with the two counters but at a gas pressure of 100 Torr significantly more large events were observed with the long counter irradiated with 15 MeV neutrons. At this pressure the diameter of the counter was equivalent to 0.5 μ of tissue. (auth)

44334 (SJC-A-70-4) CALORIMETRIC DETERMINATION OF ABSORBED DOSE RATE OF EPOXY RESIN IRRADIATED IN JRR-4. Sakata, Suoh; Inada, Tetsuo (National Inst. of Radiological Sciences, Chiba (Japan)); Doke, Tadayoshi (Tokyo Univ. (Japan). Inst. for Nuclear Study); Moriyama, Noboru; Katoh, Kazuaki (Japan Atomic Energy Research Inst., Tokai). Jun 1970. 19p. (CONF-700529-1). Dep. CFSTI (U. S. Sales Only).

From Conference on Absolute Determination of Radiation Dose and Absorbed Dose Standard, Riso, Denmark.

For the purpose of measuring the absorbed dose of the specimen irradiated by some high dose rate radiations such as radiations in a nuclear reactor, two sets of adiabatic type calorimeters were designed, manufactured, and used. One is of the absorber of epoxy resin, and the other is of graphite; the latter is needed to separate the dose of epoxy resin into that due to γ-rays and that due to neutrons. The calorimeters were hung down into a vertical experimental pipe tentatively called K-pipe for the present. Measurements were made at reactor power of from 0.05 to 2.5 MW, to clarify the correlation between the specimen's dose and the reactor's power. Dependency of the dose rate on the location of the specimen in the pipe was examined only at 2.5 MW, since the relative contribution of neutrons and γ-rays to the total dose seems almost constant unless the reactor power is very low. Calibration of the calorimeters, namely the conversion of the voltage increase of the meter to the absorbed dose rate, was made with a known γ-ray field. (auth) (Japan)

44335 THERMOLUMINESCENT DOSIMETRY OF ALUMINUM OXIDE. McDougall, R. S.; Rudin, S. (Montefiore Hospital and Medical Center, Bronx, N. Y.). Health Phys.; 19: 281-3(Aug 1970).

An investigation has been conducted to explore the possibility of using solid state Al_2O_3 in thermoluminescent dosimetry. The dosimeters were exposed to radiation energies ranging from 100 keV to 35 MeV. They displayed a constant response from 500 keV to 35 MeV comparable to LiF, and permitted accurate readings from 100 mrad to 10^3 rad. In addition, it was found that Al_2O_3 exhibits superior linear dose characteristics to LiF. The dosimeters are rugged, easily cleaned, easily annealed, and are inexpensive, costing one-quarter the price of solid LiF. (auth) (UK)

44336 MEASUREMENT OF ABSORBED DOSE OF ELECTRONS WITH A DIFFERENTIAL CALORIMETER. Okabe, Shigeru; Tsumori, Kunihiko; Tabata, Tatsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 45-9(1969).

A differential calorimeter has been designed for measuring absorbed dose of electrons of energies below 8 MeV. Its performance characteristics have been investigated with electrons of energies 1 to 6 MeV. The smallest thicknesses of the sample for which the measurement was possible with this device were a few percent of the practical range of incident electrons, and the response was linear over the region of irradiation current tested (up to 2 mA). (auth)

44337 VOLUMETRIC GAMMA DOSE MEASURING SYSTEM USING FLUOROCARBONS. Jeltsch, E.; Graf, W. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 16: 55-6(1970). (In German).

The system based on volumetric determination of radiolytic gas production as a function of gamma dose is described. It is especially suitable for nuclear reactors. Tests and calibrations were made up to $4 \cdot 10^{10}$ rad(C). Also, an arrangement for indirect temperature determinations at reactor irradiations is given. (auth)

44338 INVESTIGATION OF THE GLUCOSE AND OXALIC ACID METHODS OF γ-RADIATION DOSIMETRY. Trusova, V. P.; Bologova, G. S.; Vasil'ev, A. V. This paper was summarized in At. Energ. (USSR); 26: 457(May 1969) as paper No. 300. (In Russian).

It is found that the radiation chemical yield of the decomposition of glucose in aqueous solutions is unambiguously determined by its initial concentration C_0 and the absorbed dose of γ-radiation D, and does not depend on the concentration after irradiation C. The weight of dry glucose changes during irradiation on account of the liberation of gaseous decomposition products. A linear relationship is observed between the dose and the difference in weight before and after irradiation. The literature data on the radiation chemical yield of the decomposition of oxalic acid in aqueous solutions are not in agreement. In view of this, the radiation chemical yield was determined. As a result of the treatment of 200 results, it was established that the radiation chemical yield of the decomposition of oxalic acid depends on the percent of its decomposition α. This dependence is expressed by an equation, and the dose was calculated. For solutions with $C_0 = 0.6$ M within the range $40 < D < 200$ Mrad, the accuracy of the dose calculation is 6.5 to 2%. (W.H.K.)

44339 A LITHIUM BORATE THERMOLUMINESCENT DOSIMETRY SYSTEM FOR RADIOLOGIC PHYSICS DOSIMETRY. Almond, Peter R. (Univ. of Texas, Houston); McCray, Kenneth; Espejo, David. Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 197-200(Jan 1970).

Although $Li_2B_4O_7$ is not presently in routine clinical use, it is shown that with further development it probably could be. The reproducibility of low keV energy dependence needs to be improved. This probably will take place when a better way of uniformly distributing the Mn throughout the phosphor is found. The change in sensitivity between batches is not critical since each batch should be calibrated, and, with the nitrogen-firing process, the sensitivity has been improved to useful ranges for radiologic physics. Therefore, $Li_2B_4O_7$ should prove very useful in the many radiologic physics measurements which involve both primary and scattered radiation of unknown quality. (auth)

44340 RADIO-FREQUENCY (OSCILLOMETRIC) ALCOHOLIC CHLOR BENZENE DOSIMETER. Horvath, Zs. (Inst. of Isotopes, Budapest); Banyai, E.; Foeldiak, G. Radiochim. Acta; 13: 150-2(1970).

The application of oscillometric analysis is a new technique in the alcoholic chlor benzene chemical dosimetry. It renders possible direct dose measurements in sealed ampoules reducing the time required for the measurement from 8 to 10 min to 1 min, contrary to the traditional titration method. If an adequately large number of measurements are carried out for calibration purposes the exactness and reproducibility of the proposed dosimetric method can be further improved. On the basis of the several thousands of measurements carried out so far this method proved to be very suitable for routine works, e.g. for measuring the radiation field of irradiating chambers point by point, for regular dose checkings, etc. (auth)

Radiometric Instruments

44341 (CEA-R-4028) STUDY OF THE DETECTION ZONE OF A GAMMA–GAMMA PROBE. Umiastowski, Krzysztof (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1970. 28p. (In French). Dep. CFSTI (U. S. Sales Only).

The detection zone of gamma-gamma density probes is determined. The results of measurements carried out in 2π and 4π geometry made it possible as a function of the length of the probes (detector-source distance) and of the energy discrimination adopted. As an example, this calculation is carried out for a probe designed for measuring the density of uranium ores. The fact that the detection zone measured with a ^{137}Cs source is greater than that obtained with ^{60}Co was confirmed experimentally. (France)

44342 NEW USES OF NONCONTACT FLAT WEIGHT, THICKNESS, AND DENSITY MEASUREMENTS. Kosmowski, A. Atomwirt., Atomtech.; 15: 385-90(Aug 1970). (In German).

Industrial measuring and control devices based on nuclear

radiation have been developed as commercial detection equipment for use in manufacturing plants. At the present, such devices are used in 50 different technical procedures in West Germany and lead to savings of 100 to 200,000 DM/yr. Starting with simple thickness determination and liquid level indicators fifteen years ago, these devices were progressively developed for higher accuracy and faster recording speed. In combination with computers, complete automation of complicated processes can be accomplished. Despite long years of development, the potential for further application and improvement has not been exhausted. (tr-auth)

Miscellaneous Instruments and Components

Refer also to abstracts 44112 and 44677.

44343 (AI-AEC-12973) LMFBR TASK 25, TRANSIT TIME FLOWMETER. Annual Technical Progress Report, GFY 1970. (Atomics International, Canoga Park, Calif.). 15 Aug 1970. Contract AT(04-3)-701. 14p. Dep. CFSTI.

The development of a flowmeter using noise-analysis techniques which will be suitable for use as a flow-measurement standard in large liquid-metal systems at temperatures to 1200°F or higher is described. Also, the development and testing of a small flowmeter for use in measuring flowrate from individual fuel assemblies in liquid-metal-cooled reactors such as the FFTF is reported. Operation of the Transit Time Flowmeter (TTF) depends upon the detection of small temperature variations (thermal eddies) at two points a known distance apart in a flowstream. The two signals are cross-correlated with a variable delay time. The delay time which gives maximum correlation is the transit time of the fluid between the sensors, which time is inversely proportional to the fluid velocity. (W.H.K.)

44344 (BRH/DEP-70-20) INVESTIGATION OF THE RESPONSE OF THE MICROLITE 287 PROBE TO MICROWAVE FIELDS. Kein, Herbert F.; Swicord, Mays L.; Brown, David G.; Moore, Robert L. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Aug 1970. 44p. CFSTI.

Tests performed on the Microlite 287 microwave oven leakage probe under laboratory and field simulated conditions are described. The probe contains a preignited mercury-neon gas which ionizes and glows in the presence of radiofrequency energy. The probe-to-probe variability and the difficulty encountered in observing the change in glow intensity seriously limit the usefulness of the probe as a measurement device. It may be useful as a device for detecting gross microwave oven leakage. (auth)

44345 (CEA-CONF-1522) REAL-TIME DATA ACQUISITION AND PROCESSING UNIT INSTALLED AT LIMEIL FOR CARRYING OUT NUCLEAR PHYSICS EXPERIMENTS. Jehannot de Penquer, Yves (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 1970. 16p. (In French). (CONF-691217-1). Dep. CFSTI (U. S. Sales Only).

From Meeting of 10 020 CII Users, Louveciennes, France.

The various parts of the installation are described. The 10020 computer is intended to acquire and process the data in real time. It has to store the data of the experiment itself and to monitor and control the experiment. The measuring channel includes detectors, a shaping and storage electronic unit and analog digital amplitude encoders for pulses of about one microsecond. The data supplied by several encoders may be correlated (time-energy). Monitoring and control data are supplied by cyclic scalers and readings are taken at a fairly slow rate. (France)

44346 (EUR-CEA-FC-547) DESIGN AND DEVELOPMENT OF AN U,H,F, CORRELATOR. Pando, Bernard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1970. 79p. (In French). Dep. CFSTI (U. S. Sales Only).

This work is intended for the construction of a high frequency correlator capable of examining the signals in the 1 MHz to 1 GHz band usually encountered in plasma physics. On examining the different correlation functions revealed by the correlator, the frequency spectra, and the relation of the dispersion of instability occurring in plasma are obtained. The correlation functions are defined by the type of correlated signals (energy of finite power). The principal applications of correlation functions as well as the conditions for the validity for their mathematical treatment are reviewed. The practical design of the correlator is then described. The correlator uses two sampling oscilloscopes which extract the paired samples from noise and adds the product of these sampling pairs according to their delay in a multi-address memory in order to eliminate the noise. Some practical results verifying the operation of the correlator are obtained by means of known signals and by comparison with the correlator LETI/15. (auth) (France)

44347 (MSAR-70-56) EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. CALIBRATION AND OPERATION OF THE UNC OXYGEN METERS. Topical Report No. 15. Carter, W. J.; Shreve, R. J.; Rodgers, S. J. (MSA Research Corp., Evans City, Pa.). Apr 1970. Contract AT(11-1)-765. 37p. (XAC-720264). Dep. CFSTI.

The performance of the UNC oxygen meters was evaluated in both high purity and carbon-contaminated sodium. The response of a total of four cells was studied. The meters responded to oxygen activity in sodium resulting from changes in cold-trap temperatures and from atmospheric contamination introduced by putting mechanical properties test specimens on stream. A precise calibration curve for the oxygen meter against chemically-analyzed, high-purity sodium and high carbon activity sodium was not accomplished. The considerable scatter in the data was caused by lack of ambient temperature control and indeterminate analytical errors in samples containing less than 10 ppm oxygen. Early models of the oxygen meter were sensitive to ambient temperature changes. A correlation between cap temperature and cell voltage gave a temperature correction coefficient of 0.35 mV/°F for one of the cells. The correction was not valid if the ambient temperature excursions were rapid. Control of the cap temperature to ±2°F was accomplished by the installation of an automatically temperature-controlled enclosure. This resulted in a significant reduction of cell voltage fluctuations. A more recent model did not show the ambient temperature sensitivity when tested in the high carbon loop. The sensitivity of the oxygen meter to sodium temperature was also evaluated. The sodium temperature of the cell was controlled to ±5°F. The operating temperature of the cells was 600°F in the high purity loop and 650°F in the high carbon loop. An average sodium-temperature coefficient of 0.47 mV/°F was determined for two cells in the high purity loop. The effect of temperature on the meter response is negligible when the temperature is controlled to ±5°F. The presence of a high carbon activity did not adversely effect the response of the oxygen meter. Carbon activity was varied by three methods: cold-trap temperature, carbon-bed temperature and plugging-indicator operation. (auth)

44348 (RHEL/R-192) TEMPERATURE STABILISED MAGNETO-RESISTOR FOR 0.1 PERCENT MAGNETIC FIELD MEASUREMENT. Mace, P. R.; Welch, E. (Rutherford High Energy Lab., Chilton (England)). Aug 1970. 20p. Dep. CFSTI (U. S. Sales Only). UK 4s. 6d.

The development of a low cost, simple flux monitor of repeatable accuracy of better than 0.1% for use in high energy nuclear physics experiments on Nimrod is described. The system is intended ultimately to control the current stabilized rectifiers and so provide a stable field control. The present day alternative methods of field measurement are compared. (auth) (UK)

44349 (UCRL-72422) THE LIVERMORE FISSION FRAGMENT ANALYZER. Stevenson, P. C.; Larsen, J. T.; Leary, J. J. (California Univ., Livermore. Lawrence Radiation Lab.). 13 Aug 1970. 11p. (CONF-700815-1). Dep. CFSTI.

From Conference on the Properties of Nuclei Far from the Region of Beta-Stability, Leysin, Switzerland.

A technique has been developed for separating ions formed in gases in times of less than 100 msec by mass analysis. The method may be applied to any chemically stable ionized species. Separations between adjacent masses are good. Transmission is comparable to that of existing on-line isotope separators. Thick and extended sources of ions may be used without degrading the performance of the device. The technique should be applicable to ionized products of nuclear reactions, such as fission, which have sufficient recoil momentum to carry them into the gases. (auth)

44350 ION SOURCES FOR ISOTOPE ELECTROMAGNETIC SEPARATORS. Camplan, Jean (CNRS, Orsay, France). pp 311-27 of Premiere Conference Internationale sur les Scurces d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The six most important types of electromagnetic separation are listed and the performances expected from the separator sources are reviewed. In fact, only two types of sources are used: the thermionic source and various plasma sources without plasma compression. The latter are examined and classified: the calutron source, the magnetron source (Freeman source), the "Scandinavian" source and the Grenoble source. (auth) (France)

44351 DESCRIPTION AND PERFORMANCE OF ION SOURCES NOW USED ON ORSAY ELECTROMAGNETIC SEPARATORS. Sarrouy, J. L. (CNRS, Orsay, France). pp 341-53 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

An electron bombardment source and a thermionic source are described, and their performances are given. Emphasis is given to the ion optics. The fact that this system must provide beams much stronger than 10 mA is also considered. (auth) (France)

44352 ION SOURCES FOR THE ELECTROMAGNETIC ISOTOPE SEPARATOR AT SEIBERSDORF. Wotke, H. (Physics Inst., Seibersdorf, Austria). pp 355-67 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The electromagnetic isotope separator at Seibersdorf is used both for the separation of stable and radioactive isotopes and for studies of interactions between heavy ions and solids. These applications necessitate the use of ion sources with circular ion extraction and beam geometry as well as ion sources with slit geometry. Both kinds of ion sources are of the low voltage, low pressure arc discharge type with side extraction and furnish ion beams from 0.1 mA up to 10 mA and more. Both types are described. (auth)

44353 HIGH INTENSITY ISOTOPE SEPARATOR ION-SOURCE. Freeman, James Harry (Atomic Energy Research Establishment, Harwell, Eng.). pp 369-82 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The low-voltage discharge source which has been used successfully at Harwell for a number of years will provide sharply focused milliampere beams of most elements for extended periods of continuous operation. Although the general principle of operation of the source remains unchanged, it has been mechanically redesigned to simplify assembly and improve performance. Water cooling at high voltage and ancillary arc-chamber heating are no longer required. The standard source body is constructed mainly of tantalum to reduce the thermal mass and to minimize chemical reaction with a wide variety of corrosive vapors. The source is fitted with an oven and a separate gas feed line. Simple modifications to the ion-source include a sputtering probe for the ionization of the platinum elements and a vacuum loading assembly which permits the rapid introduction of solid samples during operation at high voltage. The extracted ion-beam can be precisely aligned by means of vacuum bellows and gimbals assembly on the external, earth potential, vacuum tank. (auth)

44354 COMPUTER AIDED DESIGN OF A NEW MASS SPECTROMETER ION SOURCE. Pittaway, L. G. (Mullard Research Labs., Redhill, Eng.). pp 449-58 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The use of a digital computer to calculate potential distributions and particle trajectories in electrostatic systems has made possible the theoretical design of a new ion source for mass spectrometers. This ion source which uses only electrostatic fields, combines simplicity of construction with a high sensitivity and low energy spread. The construction method described is relatively simple and economical and allows the source to be satisfactorily outgassed for high vacuum operation. The source can operate over a wide range of electron emission current with no appreciable change in energy spread. Consequently, a maximum sensitivity in the region of 10^{-2} A/torr at 10 mA emission can be achieved, in spite of the loss of over 80% of the ion current to the two meshes. The ions are formed into a substantially parallel beam with an axial energy spread down to 0.5 volts overall with a reduced sensitivity of $3 \cdot 10^{-3}$ A/torr. Further development may make a lower energy spread possible. (W.H.K.)

44355 PRODUCTION OF FINE ION BEAMS. Drummond, I. W.; Long, J. V. P. (Cambridge, Univ., Eng.). pp 459-68 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

Fine ion beams are now being increasingly used for a number of purposes. This paper shows that the duoplasmatron is a suitable source for an ion probe-forming system. Details are given of the precautions that must be taken with the electrical supplies to the source and of the focusing system employed to demagnify the ion beam. Ion beams with diameters as low as 0.2 μm have been achieved. (auth)

44356 ION SOURCE WITH IMPACT LASER FOR A MASS SPECTROGRAPH: APPLICATION TO EXACT ISOTOPIC ANALYSES OF SURFACES. Eloy, Jean Francois (CEN, Grenoble, France). pp 617-33 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625

A mass spectrograph equipped with a laser impact ion source is presented. The advantage of this system for point isotopic surface analysis is pointed out. The effect of laser parameters on ionic emission is shown for a UO_2 sample. (auth) (France)

44357 SEMI-AUTOMATIC EQUIPMENT FOR EVALUATION OF PHOTOISODOSE CURVES. Hawliczek, Fritz (Barmherzigen Schwestern, Linz, Ger.). Strahlentherapie; 139: 462-4(Apr 1970). (In German).

For radiotherapy, dose distribution is studied by x-ray pictures through a phantom. The x-ray film, thus obtained, is scanned with a densitometer and isodose curves are printed out on paper. The necessary electronic equipment is described and depicted by one photograph and one diagram. (H.B.G.)

44358 PHASE SENSITIVE AMPLIFIER SYSTEM FOR OPTICAL MEASUREMENTS. Fujino, Takahiro; Yoshida, Toshio; Shono, Yoshihiko; Okayama, Masatoshi. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 62-4(1969).

A phase sensitive amplifier system suitable for measurements of the optical properties of irradiated semiconductors is reported. The light is chopped at about 800 Hz by a mechanical chopper and then shed on a sample. Signals to be measured, such as signals from a photomultiplier or photoconductor, are amplified by high-gain and low-noise ac amplifiers and converted into dc signals by phase sensitive rectifiers. The gain as a whole is about 1000. (auth)

44359 SIMPLY CONSTRUCTED PROTON NMR PROBE FOR HIGH FIELD SUPERCONDUCTING SOLENOID CALIBRATION. Sari, Seppo O.; Carver, Thomas R. (Joseph Henry Labs. of Physics, Princeton, N. J.). Rev. Sci. Instrum.; 41: 1324-6(Sep 1970).

A proton nuclear resonance probe for high field calibration of room temperature access superconducting solenoid fields is described. The probe may be made in a simple fixed-tuned version, or a tunable version to cover the range from about 40 to 70 kG. Such a probe has the advantage that it may be used on the end of a long probe stem, may be made quite small if necessary, has a high Q, may be used to calibrate homogeneity and persistence easily, may be tested prior to use with DPPH, and may be constructed in just a few hours. The probe can be adapted to use at liquid helium temperatures utilizing ^{3}He samples. (auth)

44360 UNIJUNCTION THERMOMETER FOR PROJECT RULISON. Peck, Robert C.; Lanter, Robert J. (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum.; 41: 1371-2(Sep 1970).

The system used to measure the temperature at the bottom of the hole before, during, and after the backfilling operation for the 40 kT nuclear device detonated in western Colorado at a depth of 2570 m on Sept. 10, 1969 is described. A unijunction oscillator is used with a digital readout. (W.H.K.)

44361 TUNGSTEN–3 RHENIUM VS TUNGSTEN–25 RHENIUM THERMOCOUPLE: SOME RECENT DEVELOPMENTS. Tseng, Y.; Schnatz, Sharon; Zysk, E. D. (Engelhard Industries, Newark, N. J.). Engelhard Ind., Tech. Bull.; 11: No. 1, 12-18(Jun 1970).

The W-3% Re vs W-25% Re thermocouple has been successfully used for approximately seven years in aerospace and nuclear applications. Some important recent developments which affect the reliability and stability of this thermocouple are described. Numerical methods used to generate a detailed e.m.f. vs temperature table in the range 0° to 2400° Celsius are described. (auth)

44362 OPEN-TYPE ELECTRON MULTIPLIERS. Tyutikov, A. M. Usp. Fiz. Nauk; 100: 467-503(Mar 1970). (In Russian).

Open-type secondary emission multipliers are widely used for recording electromagnetic radiation in the spectral range from 1 to 1500 Å with energies up to several tens of keV and also for low and medium-energy ions and neutral particles. These devices include an electro-optical system with secondary-emission amplification of the electron flux generated by the radiation at the cathode. Construction problems of these instruments are

reviewed, examining the materials used for dynodes and cathodes and describing the theories advanced to explain the operation and the processes resulting from the interaction of the emitting surfaces with air and the electron beam. The radiation is recorded by means of an electron multiplier on the basis of the output current and of the voltage pulses generated by the interaction of the radiation with the material of the cathode. The instruments are able to record ion currents of 10^{-19} to 10^{-12} A and therefore are widely used for mass spectrometry, and for the spectroscopy of soft x radiation in the 10 to 300 Å wavelength range and for studying the passage of ions and electrons through matter. Other applications include recording of scattered and secondary electrons in electron microscopes and reception of the TV picture of a surface. (Review article 157 ref.). (TTT)

44363 CONVEX CURVED CRYSTAL X-RAY SPECTROGRAPH. Birks, L. S. (Naval Research Lab., Washington, D. C. Rev. Sci. Instrum.; 41: 1129-32(Aug 1970).

The convex side of a curved crystal will diffract a continuous range of x-ray wavelengths simultaneously. Thus, it is useful for spectral analysis of flash x-ray tubes or plasmas where there is not sufficient time to scan through the spectrum with a spectrometer. It is also convenient for detecting impurities in x-ray targets and could be used for x-ray spectrochemical analysis. The choice of analyzing crystal, the particular diffracting planes, and the orientation of the bending axis allows a considerable versatility in intensity and dispersion including the recording of two or three separate spectra in a single exposure. (auth)

44364 RESISTIVITY MEASUREMENTS BY SQUID. Hanabusa, M.; Silver, A. H. (Ford Motor Co., Dearborn, Mich.). Rev. Sci. Instrum.; 41: 1235-6(Aug 1970).

A method for resistivity measurements of metals with a superconducting quantum interference device (SQUID) is described. The metal sample is inserted in a superconducting ring of the SQUID, and an external field step is suddenly applied or removed. The flux change associated with the eddy current of the sample is measured with the SQUID as a function of time. (W.H.K.)

44365 VOLTAGE PROGRAMMED OSCILLATOR FOR QUADRUPOLE MASS SPECTROMETERS. Zipf, Edward C. (Univ. of Pittsburgh). Rev. Sci. Instrum.; 41: 1236-7(Aug 1970).

A voltage programmed rf oscillator (VPO) has been developed for satellite and rocket borne mass spectrometers which is simple in design, rugged, and entirely transistorized. The circuit generates a sinusoidal output that can be varied smoothly over the range 0.2-1200 V (peak to peak) in response to a nominal 0-25 V dc input signal. A diagram of the VPO circuit and typical component values are given. (auth)

44366 POWER-LINE BIDIRECTIONAL ZEEMAN MODULATOR FOR NQR SPECTROSCOPY. Muha, G. M. (Rutgers–The State Univ., New Brunswick, N. J.). Rev. Sci. Instrum.; 41: 1238-40(Aug 1970).

The circuit for a bidirectional Zeeman modulator for magnetic field modulation in an NQR spectrometer is presented. (W.H.K.)

44367 BASELINE STABILIZATION IN DIRECT COUPLED COUNTING SYSTEMS. East, Larry V. (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum.; 41: 1245-6(Aug 1970).

A baseline stabilization circuit for an analog-to-digital converter (ADC) is given. A high-gain differential comparator is used in a feedback loop of the ADC input amplifier. (W.H.K.)

44368 GENERATORS OF UNIFORM DISTRIBUTED PULSES FOR THE NUCLEAR LABORATORY. Deschamps, J. (Institut Physique Nucleaire, Orsay, France); Hrisoho, A.; Soucek, B. Nucl. Instrum. Methods; 84: 253-6(1970).

The transformation of any probability distribution to a uniform one is studied. The theoretical transfer function of a circuit able to transform monochromatic Poisson distributed pulses to random pulses with uniform amplitude density function is studied. The diagram of a random time-random amplitude pulse generator is given with the experimental results. The generator does not need high precision elements. It is useful as a test generator on systems for random data handling. (auth)

44369 USE OF COMPOUND SEMICONDUCTORS IN A SPUTTERING ION SOURCE FOR ION IMPLANTATION. Allen, R. M. (SERL, Baldock, Eng.). Nucl. Instrum. Methods; 84: 325-6 (1970).

The use of compound semiconductors in a modified Hill and Nelson sputtering ion source is described, and compared with other methods of using this source to produce ions for the implantation of semiconductors. (auth)

44370 PICOSECONDS TIME SCALE CALIBRATION OF TIME TO PULSE-HEIGHT CONVERTER WITH SAMPLING OSCILLOSCOPE. Cho, Z. H.; Bohm, C. (Univ. of Stockholm). Nucl. Instrum. Methods; 84: 327-31(1970).

A simple calibrator for a time to pulse-height converter using a sampling oscilloscope is described. Inherent small time jitter of the sampling sweep unit allows accurate time scale calibration in a very simple manner in a wide range of time scales. One sampling oscilloscope is all that is needed for the calibration and the time calibration capability has been extended down to the picosecond region. Performances of the calibrator and two additional signal pickoff circuits for calibration are also presented. (auth)

44371 DISCUSSION OF THE FINITE SLIT LENGTH ERROR IN POSITRON ANNIHILATION EXPERIMENTS. Mogensen, O. E. (Technical Univ. of Denmark, Lyngby). Nucl. Instrum. Methods; 84: 293-6(1970).

In linear slit measurements of the angular correlation of annihilation photons the use of finite detector slit lengths gives rise to an error in the measured curves. It is shown that the point sample approximation, which is usually used in calculations of this error, always will give a far too large error under typical experimental conditions. The numerical values of the error for the free electron case are presented. The correct error is about 3 to 7 times smaller than the error calculated in the point sample approximation. (auth)

44372 PERFORMANCE MEASUREMENTS OF THE SCANDINAVIAN TYPE ISOTOPE SEPARATOR WITH A DUOPLASMATRON ION SOURCE. Arminen, E. (Univ. of Helsinki). Nucl. Instrum. Methods; 85: 109-14(1 Aug 1970).

A simple duoplasmatron ion source using a permanent magnet has been constructed. The properties of this in connection with a low intensity isotope separator are investigated using different noble gases. Special attention is devoted to the obtainable ion currents, including multiply charged ions. The focusing and contamination characteristics of the separator at ion currents higher than those normally used in low intensity machines are studied. (auth)

44373 PASSIVE SPLITTERS FOR FAST PULSE PROCESSING. Corwin, W. C.; Porges, K. G. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 85: 155-6(1 Aug 1970).

A resistive impedance matching circuit for splitting fast pulses with unequal attenuations ϵ,η can be constructed with $1-\epsilon = 2\eta(1-\eta)$. With uneven splitting an additional resistor is required shunting the weaker signal to ground in order to maintain constant impedance throughout. (auth)

44374 ABSOLUTE MANOMETER FOR GAS PRESSURES IN THE RANGE OF 10^{-3} TO 10^{-2} TORR. Acerbi, E.; Castiglioni, M.; Dutto, G.; Fait, G.; Resmini, F.; Succi, C. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nucl. Instrum. Methods; 85: 45-8(1 Aug 1970).

We describe the characteristics of a manometer for absolute pressure measurements of gases in open vessels, and under steady flow conditions. The analysis of the instrument's performance is carried out in some detail and shows that a precision of 1.2% in the pressure range between 10^{-3} and 10^{-2} torr has been obtained. The manometer was designed for a gas target. (auth)

44375 POWER SUPPLY FOR SUPERCONDUCTING MAGNET. Britton, Richard B.; Sampson, William B. (to United States Atomic Energy Commission). U. S. Patent 3,521,207. 21 Jul 1970. Filed 27 Sep 1968.

A power supply for energizing a coiled superconductor forming a magnet subject to localized, normal resistance flux jumps and having a bore in which the magnetic field is produced is described. A low resistance is connected between one set of ends of metallic bars, and the opposite ends are connected to the coiled superconductor to form an endless circuit. Channels extend longitudinally along the metallic bars between the ends of the bars. Cooling means comprising a cryogenic fluid for causing the superconductor to have zero resistance while cooling are applied at the second ends of the bars to flow in the cooling channels. Heat sources are applied at the other ends of the bars to provide a temperature difference between the ends of the bars and for producing a current flow through the superconductor and a corresponding magnetic field in the bore of the magnetic. The apparatus is suitable for producing magnets that operate below 17.5°K and that produce a magnetic field in the kilogauss range. (B.L.M.)

44376 PULSE-STRETCHING CIRCUIT. Larsen, Robert N. (to United States Atomic Energy Commission). U. S. Patent 3,510,691. 5 May 1970. Filed 13 Jan 1967.

The voltage pulse-stretching circuit that is described has a capacitive differentiator to convert an applied voltage pulse to a current pulse. A diode switching circuit applies the current pulse to a storage capacitor to provide across the capacitor a voltage pulse having a duration determined by the discharge rate of the storage capacitor and a value, which is the integral of the current pulse. (Offic. Gaz.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 44258, 44358, and 44819.

44377 (COO–2006-1) FISSION FRAGMENT INDUCED ELECTRICAL TRANSIENTS. Technical Progress Report. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). [1964]. Contract AT(11-1)-2006. 10p. Dep. CFSTI.

Research and progress in measuring electrical transients caused by the passage of fission fragments through dielectric materials are reported. Positive measurements of fission fragment pulses were made using ordinary soda glass cover slides. (W.H.K.)

44378 (HMI-B–92) REPORT ON INVESTIGATIONS OF RADIATION RESISTANCE OF THE RTL-INTEGRATED CIRCUIT FBH 162. Spencker, A.; Siegel, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Mar 1970. 32p. (In German). Dep. CFSTI (U. S. Sales Only).

The FBH 162 integrated circuit represents two NOR gates with two inputs each. Changes of the physical properties of individual devices and of signal transmission properties of the entire IC by means of 100 kV-X-ray radiation, ^{60}Co-X-ray radiation, 1.5 MeV electron radiation, and reactor neutron radiation are investigated. Corresponding to the increasing base recombination currents of the IC transistors the different types of radiation damage are discussed. Decrease of transistor current gain below B-12 marks the end of the IC function. (auth)

44379 EFFECT OF CHANNELING ON THE SCINTILLATION RESPONSE OF NaI(Tl) TO ^{4}He AND ^{16}O IONS. Altman, M. R.; Dietrich, H. B.; Murray, R. B. (Univ. of Delaware, Newark). Phys. Lett., 32A: 423-4(24 Aug 1970).

Data presented confirm an anisotropy in the scintillation response of NaI(Tl) to MeV charged particles. Particles channeled between crystal planes have a larger light output than particles incident in a random direction. (auth)

44380 ORIENTATION DEPENDENCE OF THE GAGE FACTOR IN ELECTRON-IRRADIATED SILICON. Littlejohn, M. A. (North Carolina State Univ., Raleigh); Gross, C. ISA (Instrum. Soc. Amer.) Trans.: 9: 126-32(1970).

Electron radiation provides a means to compensate (reduce) the thermal coefficient of resistance (TCR) and thermal coefficient of gage factor (TCGF) of silicon strain gages. This paper reports further studies of this effect and, specifically, reports on the orientation dependence of the gage factor of electron-irradiated n-type silicon. Data are presented for the gage factor versus temperature for various crystal orientations and resistivities. The results indicate that it is possible to choose a crystal orientation (which is not necessarily an axis of high symmetry) such that the TCGF can be further reduced. An analytical model verifies the data presented and lends support to the idea of further reduction of the TCGF of silicon strain gages. (auth)

44381 RADIATION RESISTANCE OF CdSe THIN-FILM TRANSISTORS. Tiainen, O. J. A. (Technical Univ., Helsinki). Phys. Status Solidi (a); 2: K231-3(16 Aug 1970).

The tolerance of CdSe thin-film transistors to fast neutrons in the Triga Mark II reactor was tested using measurements of the drain current. The irradiation temperature was 50°C, and a gate voltage of 0 and ±5 V was used. After a dose of 4.4×10^{16} n/cm^2, small changes were noted in the transistor performance. It is concluded that, in comparison with other semiconductor components, CdSe thin-film transistors show a good radiation resistance. (D.L.C.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 44003.

44382 (STI/PUB-233) PEACEFUL USES OF ATOMIC ENERGY IN AFRICA. Proceedings Series. Proceedings of a Symposium Held in Kinshasa, Congo, July 28-August 1, 1969. (International Atomic Energy Agency, Vienna (Austria)). Jan 1970. 587p. (In French and English). (CONF-690711). IAEA $16.00.

Separate abstracts were prepared for 31 of the 72 papers appearing in these proceedings. An abstract of one of the other papers (Induced Mutation Research In Plant Breeding) appeared previously in NSA. Seven of the other papers appear in the proceedings in abstract form only. Thirty three of the other papers were not within the scope of NSA. These papers discussed subjects in the areas of tracer applications in agriculture, hydrology, geology, medicine, and biological sciences, training courses in radioisotope techniques, Mossbauer spectrometry, fluorescence studies, and the activities of the regional radioisotope center for the Arab countries. Reports and recommendations relating to each section of the symposium are presented and a list of participants and officers of the symposium as well as an author index are also given. (E.R.B.)

For abstracts of individual papers see: 43973–43975, 44081, 44082, 44108, 44137–44141, 44268, 44383–44387, 44460, 45002, 45010, 45386, 45786, 45787, 45859, 45860, 46004, 46005, and 46092–46095.

Basic Processes

44383 RADIOISOTOPES IN ZAMBIA. Patel, I. C.; Ward, A. H. (Univ. of Zambia, Lusaka). pp 33-6 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The development of nuclear science and techniques in Zambia is discussed. The program was initiated by the University of Zambia after its establishment in 1966. At present, investigations using radioisotopes are under way in medicine, crop production, and veterinary sciences. Technical assistance from IAEA will greatly expand such activities. It is hoped to start a personal radiation monitoring service in the country. The problems of professional and technical personnel are discussed and their solution outlined. (auth)

44384 EXAMPLE OF TECHNICAL CO-OPERATION IN NUCLEAR AGRONOMY. Lespinat, P. A.; Marini, P. (CEA/ORSTOM, Abidjan, Ivory Coast). pp 37-43 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The principal results obtained in the Ivory Coast by the use of radioactive tracers and radiation equipment (neutron depth moisture gauges in particular) in the field of agronomical research in a tropical environment are given. These results are the outcome of work performed in the isotope laboratory set up in 1964 at the ORSTOM Centre, Adiopodoumé, by the CEA, and carried out in collaboration with the research workers of ORSTOM and of various other institutes specializing in the following subjects: plant physiology, agronomy, bioclimatology, nematology, and entomology. (auth)

44385 USE OF ATOMIC ENERGY IN AGRICULTURE: FUTURE PROSPECTS IN AFRICA. Bouyer, S. (Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres, Paris). pp 47-58 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The methods by which atomic energy can be used in agriculture vary considerably, depending on the properties of the radiations emitted by radioactive isotopes. Tracer techniques are now being applied extensively. The phenomenon of isotope dilution has been used for making quantitative determinations. Interactions between radiation and matter have been used to induce chromosome mutations for the purpose of altering physiological functions or even for the complete destruction of living organs. In soil science these techniques can be used to study physical properties, the dynamic properties of fertilizer elements, optimum methods of fertilizer application, evolution of organic matter, and phenomena of soil formation. In plant physiology it has been possible to explain certain phenomena in mineral nutrition and biosynthetic metabolism. In plant genetics some important mutations have been obtained by irradiation of seeds and other plant organs. In work concerned with plant protection these methods can help clarify questions of insect biology and pesticide behaviour in the soil and in plants; in certain cases they can also contribute to the elimination of harmful insects (release of males sterilized by irradiation). Nuclear methods could also be applied to the study of physiological and biochemical processes of importance in animal husbandry. In addition, irradiation can also serve as a means of achieving improved food preservation. Certain applications would appear to have priority as far as Africa is concerned, namely determination of soil moisture content by means of neutron gauges, study of the dynamic characteristics of certain fertilizer elements, rational utilization of fertilizers, plant physiology, obtaining radiation-induced mutations (in certain cases carefully chosen by experts), biology of crop parasites, sterilization of certain insects, animal physiology, and the irradiation of various foodstuffs. (auth)

44386 NUCLEAR TECHNIQUES IN FOOD AND AGRICULTURE AND INTERNATIONAL COOPERATION IN THEIR USE. Fried, M.; Sigurbjoernsson, B. (International Atomic Energy Agency, Vienna). pp 59-68 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Nuclear techniques are used in research and production at all levels of the food chain from soil and water, plant breeding, plant production and protection, animal production and health, to food protection both in the field and in storage. In soil and plant production research, isotopically labeled fertilizers are used in order to trace nutrient elements as they are taken up by crop plants. Water can be isotopically labeled and use can also be made of the way in which hydrogen atoms scatter neutrons. When radiation is applied to living matter, its genetic make-up can be changed. Such changes, called mutations, occur naturally at a very low rate, but radiation can increase their frequency by a factor of 100,000. The use of certain chemicals can also result in the appearance of mutations. These applications have resulted in the creation of a number of superior crop varieties and lines. Radiation can, however, affect genetic matter also to produce sterility, e.g. in insects. Vast numbers of sterile insects are released in an infested area where they compete with the native population for mating partners. Repeated releases of vast numbers of sterile insects result in a quick reduction of the natural population which can eventually lead to complete eradication of the species in the release area. Radiation can be used to attenuate parasitic larvae attacking animals. The parasites that have thus lost their virulence are used in the production of animal vaccines. Isotopic tracers are used to study the movement and metabolism of nutrients in animal production and are particularly useful in studies of essential micronutrients. This unique ability of isotopic tracers to enable detection of chemicals in minute quantities forms the basis for a new program on studies of harmful pesticide residues on plant and animal foods. The sterilizing and killing effect of radiation has been shown to be uniquely effective in preventing or delaying spoilage in a variety of food commodities. To foster international activities in the field of nuclear science in food and agriculture, the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture carries out a single joint program of work approved by the two parent organizations. To carry out work in all these fields, the Division relies heavily on the concept of coordinated research based on research contracts or research agreements. A large part of the work is carried out under various technical assistance projects including expert advice, equipment and training, and through the two UNDP Special Fund Projects executed by the IAEA. The IAEA Laboratory plays an indispensable role in the Division's programs by providing various coordinating services, research, and specialized training. (auth)

44387 USES OF RADIOACTIVE ISOTOPES AND RADIATION SOURCES IN BIOLOGICAL STUDIES IN U. A. R. Hashish, S. E. (Atomic Energy Establishment, Cairo). pp 257-66 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

An attempt is made to give examples rather than a review of the uses of radioactive isotopes and radiation sources in biological studies in U.A.R. Studies along these lines started early in 1955 and are still progressing. The prospects of future developments and improvements are unlimited. The studies are classified according to the radiotechnique adopted. The techniques so far used in U.A.R. include all the techniques known elsewhere. Some detailed modifications and combinations of more than one technique have been successfully introduced. Both in basic and applied biological studies, one or more of the following techniques have been applied, namely tracer technique, isotopic dilution analysis, autoradiography, radiochromatography and electrophoresis, double or multi-bioassays, radioactivation analysis, neutron absorption analysis, and use of different radiation source for somatic and/or genetic effect studies. Mass spectrometry for stable isotopic studies in the field of biology has been recently used. Studies undertaken in the applied fields of biology, e.g. in medicine (diagnosis and therapy) and agriculture (soil, plant, and animal) have proved extremely valuable from the practical and developmental points of view. (auth)

44388 IN-VIVO NEUTRON ACTIVATION ANALYSIS OF CALCIUM IN MAN. Cohn, S. H.; Dombrowski, C. S.; Fairchild, R. G. (Brookhaven National Lab., Upton, N. Y.). Int. J. Appl. Radiat. Isotop.; 21: 127-37(Mar 1970).

Absolute levels of total-body calcium can be determined by exposing a subject to a uniform neutron depth flux from 14-MeV neutrons produced by the $^{3}H(d,n)^{4}He$ reaction. The induced ^{49}Ca can be measured with a whole-body counter with an invariant response to geometry and attenuation. This in vivo neutron activation technique for measuring Ca was shown to have an accuracy of ±1.7 per cent in phantom studies. While 14-MeV neutrons permit the analysis of total-body Ca with a dose to the subject of 0.637 rem, the use of lower energy neutrons (4.5 MeV) from portable (α,n) sources such as PuBe should prove even more effective, since only one-fifth of the dose to the subject is required. The neutron activation technique provides a valuable tool for the measurement of the rate of loss of Ca from the body in the study of calcium kinetics in normal aging subjects, as well as in numerous disorders of the skeleton involving the loss of calcium. The radiation dose to the subject is comparable to that received in standard diagnostic procedures. Ca is only one of a number of important body elements that can be measured by this technique. In vivo neutron activation analysis has considerable potential for use in medical research and diagnosis in living man. (auth) (UK)

44389 SMALL GROWTH CHAMBER FOR LABELLING PLANTS WITH ^{14}C. Pape, G.; Bobleter, O. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 301-2(1970). (In German).

A 40 l growth chamber was built for the production of uniformly ^{14}C-labeled plant substances. With the aid of cooling spirals the atmospheric humidity in the chamber could be kept between 65 and 75%. The $^{14}CO_2$ necessary for the assimilation was obtained by the reaction of perchloric acid with barium carbonate. The specific activity of the cellulose prepared from the grown oat plants amounted to 8 μCi/g of cellulose. The growth chamber is specially suited for labeling and biochemical investigation of young plants. (auth)

44390 STUDIES ON TETANUS TOXIN AND TOXOID. IV. INTERACTION OF FORMALDEHYDE WITH TETANUS TOXIN. Dawson, D. J.; Mauritzen, C. M. (National Biological Standards Lab., Canberra, Australia). Aust. J. Biol. Sci. 22: 1217-27 (Oct 1969).

The binding of formaldehyde with tetanus toxin under mild detoxification conditions (0.1m phosphate buffer, pH 7.0, 0.005 to 0.06m HCHO, 20 to 37°C) was studied quantitatively by using (^{14}C)formaldehyde. When detoxification was followed with time (0.005m HCHO, 37°C), the toxin showed a characteristic immediate drop in lethality (80%), followed by a slower detoxification, whereas the combination of the HCHO was a more gradual process. When a fixed time period was used (5 days, 20 and 37°C) at least 0.02m HCHO was required to destroy the lethality of the toxin towards mice, and at this concentration approximately 60 moles of HCHO were bound per mole of toxin. Fractionation of a partially detoxified toxin indicated the presence of a range of molecular species with varying formaldehyde binding and lethality. The effect of introducing l-lysine and l-leucine into the formaldehyde-toxin interaction was also examined and the use of ^{3}H-labelled lysine or leucine allowed an estimate of the amount of amino acid bound to the toxin to be made. The chemical nature of the formaldehyde-toxin interaction was also studied indirectly by substituting poly-l-lysine and poly-l-glutamic acid for tetanus toxin in detoxification conditions. The results have been discussed in terms of the concepts of protein-formaldehyde interaction. (auth) (Australia)

44391 ^{51}Cr LABELLING OF MOUSE PERITONEAL CELLS SELECTIVE LABELLING OF PERITONEAL MACROPHAGES. Ronai, P. M. (Univ. of Sydney). Pathology; 2: 15-20(1970).

Chromium-51 as $Na_2{}^{51}CrO_4$ is suggested as a peritoneal macrophage label that more closely conforms to the criteria of an ideal cellular label than do radiocolloids. Chromium-51 was previously assumed to be an entirely unselective cellular label, and this may have discouraged its use to label peritoneal macrophages in the presence of other cellular constituents of the peritoneal fluid. Autoradiographic studies showed marked selectivity of ^{51}Cr for macrophages when $Na_2{}^{51}CrO_4$ was incubated with mouse peritoneal cells. This selectivity was most obvious with in vivo labeling. The main objection to the use of ^{51}Cr is its elution from labeled cells. Reasons are given why this does not present a serious problem, either qualitatively or quantitatively. (auth) (Australia)

44392 DEVELOPMENTS IN WATER QUALITY RESEARCH. Proceedings of the Jerusalem International Conference on Water Quality and Pollution Research, June 1969. Shuval, Hillel I. (ed.). Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers, Inc. (1970). 323p. $17.50. (CONF-690644).

Separate abstracts were prepared for two of the 20 papers appearing in these proceedings. The other papers deal with topics in the general areas of water quality management (7 papers), wastewater treatment and utilization (10 papers), and marine pollution (1 paper). A list of contributors and a brief subject index are also included. (E.R.B.)

For abstracts of individual papers see: 44393 and 46010.

44393 USE OF RADIOISOTOPE TRACERS IN THE STUDY OF THE DISPERSION AND INACTIVATION OF BACTERIA DISCHARGED IN COASTAL WATERS. Gilat, Ch. (Soreq Nuclear Research Center, Yavneh, Israel); Shuval, H. I.; Yoshpe-Purer, Y.; Cohen, N. pp 269-88 of Developments in Water Quality Research. /Shuval, Hillel I. (ed.). Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers, Inc. (1970).

From Conference on Developments in Water Quality Research, Jerusalem, Israel. See CONF-690644.

The application of radioisotope tracer techniques for the in situ study of bacterial dispersion patterns and inactivation kinetics of sewage effluents in coastal waters is demonstrated. Experimental results, although preliminary and of a qualitative nature, indicate a relatively high bacteria disappearance rate in the coastal waters of Israel. Further experiments and a more refined methodology will make it possible to determine parameters essential to the rational utilization of the natural capacity of the sea in purifying microbial contamination. (E.R.B)

44394 SYMPOSIUM ON THE RADIOIMMUNOASSAY OF PROTEIC AND POLYPEPTIDE HORMONES, SAN REMO, ITALY, NOVEMBER 4-5, 1968. J. Nucl. Biol. Med.; 13: 1-48(Jan-Jun 1969). (CONF-681136).

Separate abstracts were prepared for the six papers appearing in this symposium. (E.R.B.)

For abstracts of individual papers see: 44395-44400.

44395 RADIOIMMUNOASSAYS. GENERAL PRINCIPLES. Felber, J. P.; Aubert, M. L. (Univ., Lausanne, Switzerland). J. Nucl. Biol. Med.; 13: 1-9(Jan-Jun 1969).

From Symposium on the Radioimmunoassay of Proteic and Polypeptide Hormones, San Remo, Italy. See CONF-681136.

The radioimmunoassay technique first developed by Yalow and Berson in 1960 has been since then adapted for the determination of several peptide hormones. It has the advantages of the high specificity of the immunologic techniques and of the high sensitivity of the isotopic methods. The major points of the technique are reviewed, as well as the problems particular to the determination of some of the polypeptide hormones. (auth)

44396 USE OF LABELLED ANTIBODIES IN THE ASSAY OF POLYPEPTIDE HORMONES. Miles, L. E. M.; Hales, C. N. (Cambridge Univ., Eng.). J. Nucl. Biol. Med.; 13: 10-13(Jan-Jun 1969).

From Symposium on the Radioimmunoassay of Proteic and Polypeptide Hormones, San Remo, Italy. See CONF-681136.

The application of radioimmunoassay techniques to the determination of polypeptide hormones using labeled antibody is discussed. The general principles of the technique are given and the specific methods for hormone assay are summarized. The effects of iodination, an integral part of the procedure, on the molecule

are mentioned and the selection of antibody for the assay is discussed in terms of kinetics and cross reactivity. (E.R.B.)

44397 RADIOIMMUNOASSAY FOR HUMAN PLASMA THYROTROPIN AND ITS APPLICATION IN THYROID DISEASE. Lemarchand-Beraud, Th. (Univ., Lausanne, Switzerland). J. Nucl. Biol. Med.; 13: 14-25(Jan-Jun 1969).

From Symposium on the Radioimmunoassay of Proteic and Polypeptide Hormones, San Remo, Italy. See CONF-681136.

A radioimmunoassay for the determination of TSH either in human blood or in experimental animals (rat) was developed that used highly purified bovine TSH for the labeling with ^{131}I or ^{125}I antiserum to bovine TSH and the international bovine USP TSH as a standard. A study was made of the specificity between the bovine and human TSH. A cross reaction was observed between antiserum to bovine TSH and human TSH; but none between antiserum to human TSH and bovine TSH. The assay was applied to the determination of human plasma TSH; and a study was made of the relation between pituitary and thyroid gland in normal subjects and in thyroid disease before and under various forms of treatment in 750 patients. Elevated levels of up to fifteen times those of normal subjects were found in myxoedema. The low initial values found in all forms of thyrotoxicosis were modified during treatment. Every qualitative or quantitative deficiency of thyroid hormone secretion (except in cases of pituitary hypothyroidism in which no TSH was found) was accompanied by an elevation of the circulating TSH: euthyroid nodular goitre, thyroid carcinoma, subacute thyroiditis, Hashimoto's disease. Treatment with thyroid hormones provoked a decrease of plasma TSH. (auth)

44398 RADIOIMMUNOASSAY OF HUMAN GROWTH HORMONE. Molinatti, G. M. (Univ., Turin); Massara, F.; Strumia, E.; Pennisi, F.; Scassellati, G. A.; Vancheri, L. J. Nucl. Biol. Med.; 13: 26-36(Jan-Jun 1969).

From Symposium on the Radioimmunoassay of Proteic and Polypeptide Hormones, San Remo, Italy. See CONF-681136.

Earlier methods for the determination of plasma and hypophysis HGH values are briefly referred to and various radioimmunological techniques reported in the literature are discussed. Attention is placed on the need for simple and reproducible procedures, together with standardized reagents, if radioimmunoassays are to become part of routine clinical laboratory practice. In this connection, the double-antibody technique already in use for a number of years in insulin determination is investigated and the results of extensive experimentation of labeling, purification, and storing procedures and conditions are reported. It is shown that ^{125}I-labeled HGH stored at $-20°C$ can be employed for at least 20 to 25 days after its preparation. Plasma HGH values observed in normal, acromegalic, and hypopituitaric subjects, in basal conditions and during insulin and glucose tolerance tests, are also presented. Results of experiments undertaken to shorten the duration of incubation and then the duration of the whole immunoassay procedure are illustrated. Comparison data both at 37°C and 4°C are reported. (auth)

44399 ACTUAL ASPECTS OF THE RADIOIMMUNOLOGICAL DETERMINATION OF PLASMA ACTH. Aubert, M. L.; Felber, J. P. (Univ., Lausanne, Switzerland). J. Nucl. Biol. Med.; 13: 37-42(Jan-Jun 1969).

From Symposium on the Radioimmunoassay of Proteic and Polypeptide Hormones, San Remo, Italy. See CONF-681136.

The purpose of this report is to present the possibility of measuring plasma ACTH with the radioimmunological method. Several techniques have been described for that purpose, and the problem of lack of sensitivity has directed several authors to set up extraction techniques. ACTH acetone extraction, with subsequent purification, extraction technique, using adsorbents, such as Fuller's earth, silicic acid, or separation with talc powder were shown to improve markedly the possibility of measuring the very low levels of plasma ACTH. The authors reported that the double antibody technique, has made it possible to detect the physiological levels of plasma ACTH. Also reported was the problem encountered in the specificity of the use of antisera. (auth)

44400 IODINATION AS A TOOL TO STUDY THE STRUCTURE OF THE PROTEIN HORMONES. Covelli, I. (Univ., Naples). J. Nucl. Biol. Med.; 13: 43-8(Jan-Jun 1969).

From Symposium on the Radioimmunoassay of Proteic and Polypeptide Hormones, San Remo, Italy. See CONF-681136.

Proteins are usually iodinated for two different reasons: high specific activity labeling in order to label a protein still retaining biological activity; and extensive iodination to follow both decrease of activity and selective reactivity of the functional groups. For structural studies, the ability of iodine to act as an oxidant as well as electrophilic reagent, its close dependence on reaction variables, with its poor selectivity make the results obtained by the iodination technique hard to interpret. However, in a few carefully controlled cases the halogen was successfully used to differentiate reactive from nonreactive residues in the proteins. Examples are briefly reported. Few structural studies on polypeptide hormones have been carried, with the exception of insulin, which has been largely studied. In this hormone differential reaction rates for the four tyrosines and the dependence of histidine iodination on the presence of Zn have been demonstrated. The special factors that may enter into glucagon iodination, and the importance of iodination in the elucidation of the structure and biological significance of calcitonin are briefly discussed. (auth)

44401 THE KINETICS OF CELLULAR PROLIFERATION IN HUMAN TISSUES. DETERMINATION OF DURATION OF DNA SYNTHESIS USING DOUBLE LABELING AUTORADIOGRAPHY. Fabrikant, J. I. (Johns Hopkins Univ., Baltimore). Brit. J. Cancer; 24: 122-7(Mar 1970).

The duration of the DNA synthesis period in normal and malignant human tissues from the larynx, trachea bronchus, and esophagus of 13 patients was estimated by a tritiated thymidine, carbon-14 thymidine double-labeling method in vitro. The DNA synthesis times ranged from approximately 10 to 25 hr, were shortest in normal tissues, and were longer in malignant tumor cells than in benign tumor cells. The double-labeling method, the analysis of thymidine labeling index data for the measurement of the S period, and a model for determining potential doubling times in human tissues are described and discussed. (auth) (UK)

44402 IODINE DETERMINATION IN HUMAN AND MOUSE TISSUES BY NEUTRON-ACTIVATION ANALYSIS. Malvano, R. (SORIN, Saluggia, Italy. CNR, Pisa, Italy); Buzzigoli, G.; Costa, A.; Cottino, F. J. Nucl. Biol. Med.; 13: 71-9(Jan-Jun 1969).

Due to its favorable characteristics of sensitivity, accuracy, and precision, neutron-activation analysis was used to evaluate the iodine content of human and mouse tissues. For man the following tissues were analyzed: skeletal muscle, diaphragm, heart, brain, lung, liver, spleen, kidney, skin, and thyroid. For mouse, the research was limited to thyroid, muscle, and plasma (total and non-dialyzable iodine). The suitability of the analytical method and the validity of the experimental procedure are discussed, and the results obtained are reported. In the case of man, despite a rather wide spread of the values and the non-normal patterns for concentration distributions found in several instances, the iodine contents were established with a sufficient precision as 350 ± 150 ppm for thyroid, 0.13 ± 0.06 ppm for liver, 0.01 ppm for brain and 0.03 to 0.05 ppm for the other tissues examined (fresh tissue basis). As regarding mouse, two main groups were studied, on the basis of different dietary iodine amounts (evaluable as about 1.8 and 0.13 μg/day). Large differences resulted for thyroid and plasma, while the muscle content was found to be practically the same regardless of the different iodine intakes: in the case of mice on the diet with higher iodine concentration the values found are 1.15 ± 0.46 μg/gland for thyroid, 10.3 ± 3.3 and 5.1 ± 2.1 μg/100 ml for whole and dialyzed plasma respectively, and 3.6 ± 1.5 μg/100 g for muscle; for the mice fed with the lower-iodine diet, thyroidal iodine resulted as 0.17 ± 0.08 μg/gland (hyperplastic thyroids), total plasma iodine 2.2 ± 0.6 μg/100 ml, non-dialyzable plasma iodine 2.0 ± 0.5 μg/100 ml, and muscle iodine 3.2 ± 1.1 μg/100 g. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 44252, 44268, 44506, and 44510.

44403 (CONF-691101–, pp 159-65) DETERMINATION OF THE EFFECTIVE HALF-LIFE OF ^{7}Be WITH A VIEW TO THE BIOLOGICAL DOSIMETRY OF HIGH-ENERGY PROTONS. Legeay, G.; Guenet, J. L.; Jaureguy, J. C. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires).

Gamma spectroscopy of beryllium-7 produced by high-energy proton-induced spallation in tissues was studied in rats for measuring the absorbed radiation dose. The measured and calculated values for the beryllium-7 activity–proton dose ratio differed somewhat; therefore, the biological factors of elimination of beryllium-7 were studied. The biological half-life of beryllium-7 induced by spallation in rats was found to be shorter than the half-life of beryllium-7 injected in rats. (W.H.K.)

44404 EXPERIMENTAL STUDIES ON UPTAKE AND DISTRIBUTION OF RADIOSTRONTIUM IN PIGS, EMPHASIZING THE EFFECT OF CALCIUM CONTENT OF FEED AND PASSAGE THROUGH PLACENTA. I. REDUCTION OF RADIOSTRONIUM DEPOSITION THROUGH CALCIUM. Werner, Hans (Univ., Kiel). Strahlentherapie; 139: 472-86(Apr 1970). (in German).

Metabolic studies of radiostrontium in pigs were conducted.

The influence of calcium in food on the strontium incorporation was investigated. A high calcium content in food reduced the incorporation up to a factor of 3. Two different age groups were examined in order to study the effect of age. There was a net effect of age, so that younger animals showed a three times higher uptake. (auth)

44405 HEAVY WATER (^2H_2O) AS SOLVENT FOR INCUBATION MEDIA IN VITRO. EFFECTS ON TWO TISSUES EXHIBITING SIGNIFICANT WATER SHIFTS: MAMMALIAN CEREBRAL CORTEX AND ETIOLATED PEA SEEDLINGS. Tower, Donald B.; Tower, Deborah A. (National Inst. of Neurological Diseases and Stroke, Bethesda, Md.). Biochem. Pharmacol.; 19: 1015-23 (Mar 1970).

Apical stem segments from 7-day-old etiolated pea seedlings when incubated in vitro in the presence of 10^{-6} M indolyl-3-acetic acid (IAA) normally exhibit significant elongation and a significantly greater (3-fold) imbibition of fluid than control stem segments. In the presence of an incubation medium made up with ^2H_2O (85%,v/v) as solvent, these effects of IAA are completely absent. Swelling of slices of cat cerebral cortex normally encountered upon incubation in vitro was unaffected by incubation in media made up with ^2H_2O (99%,v/v) as solvent except for: (1) slices from neonatal kittens, normally resistant to swelling in vitro, where 16% swelling was encountered; and (2) slices from adult cats when incubated in ^2H_2O media containing 5 mM K^+, where a 2-fold increase in swelling was encountered. In the latter case, tissue fluid spaces accessible to sucrose and to chloride did not change proportionately, suggesting an intracellular locus for the extra fluid of swelling. Contents of electrolytes in control and ^2H_2O-treated slices were similar except for K^+, which was significantly elevated (+ 18 to 24 μmoles/g) in slices incubated in ^2H_2O media containing either 5 mM or 27 mM K^+. The findings are discussed in terms of known effects of ^2H_2O on various biological systems, including plant tissues and the mammalian nervous system. (auth)

44406 TRANSFER AND DISTRIBUTION OF TRITIUM AMONG THE MAIN COMPONENTS OF MILK PRODUCED BY COWS HAVING INGESTED CONTAMINATED WATER. Kirchmann, R.; Lafontaine, A.; Van den Hoek, J.; Koch, G. (CEN, Mol, Belg. Institut d'Hygiene et d'Epidemiologie, Brussels. Laboratorium voor Fysiologie der Dieren, Wageningen, Netherlands). Compt. Rend. Soc. Biol.; 163: 1459-63(1969). (In French).

The distribution of tritium among the water, total dry matter, fats, casein, and lactose of milk from cows fed contaminated water was measured. Two series of tests were made: the first from a single ingestion of tritiated water and the other from daily ingestion. The distribution of the tritium for the two types of ingestion are tabulated. After ingestion the tritiated water was distributed in the general water pool of the animal. The results showed that, in the case of repeated ingestions, the ratio of the specific activities of dry matter/H_2O and fats/H_2O increased with time. This indicates that the fraction of THO that is incorporated in the organic components is secreted more slowly than that of the H_2O pool of the body. (J.S.R.)

44407 PREDICTION OF TISSUE LOSS IN EXPERIMENTAL FROSTBITE WITH RADIOACTIVE XENON. Sumner, David S.; Criblez, Thomas L.; Novak, John K.; Doolittle, William H. (Arctic Medical Research Lab., Fort Wainwright, Alaska). Surg. Gynecol. Obstet.; 131: 417-23(Sep 1970).

The clearance of ^{133}Xe was used to estimate the blood flow in the paws of 30 rabbits with freezing injuries of varying severity. In those paws which ultimately became necrotic, the blood flow was markedly depressed immediately after thaw and continued to fall during the following week, eventually approaching zero. Flows in paws with mild injuries were only slightly and inconsistently changed after thaw. The level of flow had prognostic significance as early as ten minutes following thaw and became progressively more revealing with the passage of time. It is suggested that the clearance of ^{133}Xe could be a valuable tool in predicting the extent of tissue loss in clinical frostbite. (auth)

44408 STUDIES ON THE ERADICATION OF ANOPHELES PHAROENSIS THEOBALD BY THE STERILE MALE TECHNIQUE USING ^{60}Co. VIII. UPTAKE, DISTRIBUTION, PERSISTENCE, AND DECAY OF RADIOPHOSPHORUS IN ADULTS OF ANOPHELES PHAROENSIS. Wakid, A. M.; Abdel-Malek, A. A.; Tantawy, A. O. (Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo). Isotope Radiat. Res.; 2: 49-54(Jun 1969).

Phosphorus-32 uptake was much more detectable by tagging during larval rather than during adult or pupal stages. Generally, radio-counts of adults increased with increasing time of exposure to ^{32}P. The abdomen and thorax gave higher radioactivity than the head, legs, and wings. The biological half-life in adult mosquitoes fed on phosphate diet after labeling was less than those deprived of such a diet. Sugar solution labeled with ^{32}P and fed to adults at different levels of radioactivity had no effect on the biological half-life. Female mosquitoes showed longer biological half-life than males. Radio-phosphorus was detectable in adult mosquitoes till their death at all levels of radioactivity used. (auth)

44409 NEW NORMAL RANGES FOR THE RADIOIODINE UPTAKE STUDY. Bernard, J. David; McDonald, Robert A.; Nesmith, Jerard A. (San Joaquin General Hospital, Stockton, Calif.). J. Nucl. Med.; 11: 449-51(Jul 1970).

Normal iodine uptake ranges in the laboratory have definitely changed over the past 15 to 20 yr at least partly due to variations in iodine exposure of the population. In addition, basic and commonsense concepts of intralaboratory quality control make it mandatory that all laboratories establish normal ranges for the iodine uptake study. A prospective study in Stockton, California, revealed normal ranges vastly different from those used previously. They are very comparable to modern normal ranges recently established in Birmingham, Alabama. Normal ranges must be reestablished as necessary with the passage of time and changes of equipment. Normal subjects must be used for this purpose, not patients suspected of having thyroid or other serious disease. (auth)

44410 COMBINATION OF THORIUM WITH BLOOD CONSTITUENTS DEPENDING UPON THE CHEMICAL NATURE OF THE COMPOUND INTRODUCED. Pavlovskaya, N. A.; Makeeva, L. G.; Orlyanskaya, R. L. (Inst. of Industrial Sanitation and Occupational Disease, Moscow). Gig. Sanit.; No. 2, 49-52(Feb 1970). (In Russian).

The results of experimental investigations on albino rats produced evidence that thorium is primarily present in the blood plasma, regardless of the method of its administration, chemical nature of the compounds introduced, and the time lapsed since their entrance into the organism. With entrance of a noncomplex thorium compound, its main bulk in the blood is bound with globulins, while in the instance of a stable complex compound its distribution in the plasma depends upon the mode of its introduction. With intravenous adminstration thorium is found predominantly in the non-protein part of the blood. (auth)

44411 EXPERIMENTAL STUDY OF SHORT-LIVED DAUGHTER PRODUCTS OF RADON IN THE RESPIRATORY TRACT. Kirichenko, V. N.; Khachirov, Dzh. G.; Dubrovin, S. A.; Klyuch, V. E.; Bykhovskii, A. V. (Inst. of Medical Radiology, Moscow). Gig. Sanit.; No. 2, 52-6(Feb 1970). (In Russian).

Knowledge of the nature of isotope distribution is necessary for assessment of the dose to basal cells of the bronchial epithelium of various parts of the respiratory tract following inhalation of radon and of its daughter products. Experimental investigations were carried out by a special method of direct alpha-spectrometry of the preparations to elucidate the nature of the radon daughter product distribution in the mucosa of bronchial epithelium of dogs and rabbits. The data permitted more accurate measurement of the dose to dosage loads on the basal cells of the bronchial epithelium after inhalation of air containing RaA, RaB, RaC and RaC^1 by experimental animals. (auth)

44412 DISTRIBUTION OF CAESIUM, RUBIDIUM, AND POTASSIUM ISOTOPES IN THE DOG AND MEASUREMENT OF CORONARY FLOW. Matthews, C. M. E.; Kibby, P. M.; Gabe, I. T.; Caldwell, R. G. (Hammersmith Hospital, London). J. Nucl. Biol. Med.; 13: 49-63(Jan-Jun 1969).

The theoretical and experimental basis of the measurement of coronary flow with potassium and rubidium isotopes was re-examined. The use of caesium isotopes was also investigated. Caesium isotopes have more suitable physical properties but rubidium isotopes appear to be more suitable biologically. The distribution of rubidium and caesium isotopes in organs of the dog was measured at about 30 min after intravenous injection. The count rate was recorded from a scintillation counter placed over the heart and was found to be constant from about 2 to 30 min after injection. The radioactivity in arterial blood was also measured at intervals. A mathematical model of the distribution of these isotopes in the body was simulated on an analogue computer. The model is based on the assumption that the isotopes act as tracers of potassium. Extracellular–intracellular exchange rates and plasma flows were adjusted to obtain radioactivity curves that matched experimental results. The model was then used to investigate theoretically the effect of variations in coronary flow, cardiac output, and exchange rates on the myocardial uptake of isotope. The computed results indicated that a constant myocar-

dial uptake can be obtained for 20 min after injection without making any special assumptions about the extraction ratio since constancy of uptake depends more on the rubidium intracellular uptake ratio being equal for different organs. It was also concluded that myocardial uptake of isotope can only be used as a measure of coronary flow if variations in cardiac output are taken into account. Other practical difficulties in the use of this method were considered. (auth)

44413 THE DIFFERENTIAL RETENTION OF ^{47}Ca AND ^{85}Sr BY THE MOUSE DURING LACTATION. Kollmer, W. E.; Berg, D. (Gesellschaft fuer Strahlenforschung, Munich). Atomkernenergie; 15: 303-5(1970).

The retention of simultaneously injected ^{85}Sr and ^{47}Ca was studied over a period of 22 days in lactating mice and in virgin controls. As expected, in the control animals the level of ^{85}Sr decreased faster than that of ^{47}Ca due to preferential elimination by the excretory organs. In the nursing dams, however, the retentions of the two isotopes did not differ over the period because of the preferential secretion of Ca by the mammary gland. The litter therefore took up much more ^{47}Ca than ^{85}Sr. The actual excretion of both isotopes by way of urine and feces was less for the dams than for the controls. The ratio of $^{85}Sr/^{47}Ca$ excreted in the urine and feces decreased for all animals during the first 4 days after injection. (auth)

44414 BINDING OF PLUTONIUM TO GLYCOPROTEINS IN VITRO. Chipperfield, A. R.; Taylor, D. M. (Inst. of Cancer Research, Belmont, Eng.). Radiat. Res.; 43: 393-402(Aug 1970).

The binding of plutonium by a sialoprotein isolated from bovine cortical bone and by transferrin was compared using a gel filtration procedure. The pH at which maximum binding of plutonium to bone sialoprotein was observed, pH 6, was different from that for transferrin, pH 7, and the magnitude of the binding was greater for bone sialoprotein. The effects of added iron and bicarbonate ions, and of removal of sialic acid on the binding of plutonium to these two glycoproteins, were also dissimilar. These results show that plutonium binds to the carboxyl groups of bone sialoprotein, and this may be responsible for the high stability of the plutonium-bone sialoprotein complex. For the plutonium–transferrin complex, the results obtained suggest that the plutonium is bound at the iron-binding sites, tyrosyl groups, and probably at other sites in the transferrin molecule. (auth)

Radiation Effects

Refer also to abstracts 44485, 44598, and 44645.

44415 (EUR-4452, pp 529-39) STOPPING POWER OF LOW ENERGY ELECTRONS IN BIOLOGICAL MATERIALS. Marshall, M.; Gibson, J. A. B.; Holt, P. D. (Atomic Energy Research Establishment, Harwell (England)).

The target theory of Lea was examined using modern data to determine whether consistent cross sections could be obtained from the inactivation of biological molecules by various radiations. The stopping power for low energy electrons and the rate of primary ionization, which are required by the theory, are not known. However, when the theory is applied to the inactivation of the enzyme, ribonuclease, a consistent value of the cross section is found for one value of the parameter used to determine the primary ionization and for one model of the stopping power for low energy electrons. The primary ionization parameter is in agreement with published values for hydrocarbon gases. The stopping power for electrons follows the Bethe–Bloch theory above 400 eV and joins smoothly with the power law, $dE/dx \propto E^{-0.5 \pm 0.1}$, below this energy. In this work gamma rays, protons, deuterons, and alpha particles were used to inactivate the ribonuclease. As much of the effect for heavily ionizing radiation is due to delta rays, further experiments on the effect of low energy electrons (produced by low energy characteristic x-rays) are in progress. Preliminary results suggest that the models used are still valid. (auth)

44416 (EUR-4452, pp 779-86) SOME THEORETICAL CONSIDERATIONS CONCERNING ULTRA-HIGH DOSE RATE SURVIVAL EXPERIMENTS. Kiefer, Juergen (Giessen Univ. (West Germany). Institut fuer Biophysik); Ebert, Michael (Christie Hospital and Holt Radium Inst., Manchester (England). Paterson Labs.).

Theoretical expectations for specific effects of ultra-high dose rates on cell survival are considered: Primary damage to target molecules in the cell may be reduced due to recombination of radicals from different tracks. It is estimated that this effect is not likely to occur below doses of 280 Krad given at dose rates of 10^{14} rad sec^{-1}. Primary damage may be modified by secondary processes. On the basis of current models it is estimated that this might be seen at doses higher than 500 rad. Since the formation of long-lived secondary or tertiary radicals is essential, the exposure must be long enough to allow the respective reactions to take place. It is concluded, therefore, that there may exist an optimal dose rate where deviations from the effects at conventional dose rates may be found. (auth)

44417 (UCB-34-P-147-X-3, pp 1-4) EFFECTS OF BETA EMITTERS ON EXCISED ROOT TIPS OF CORN AND PEAS. Day, Paul R. (California Univ., Berkeley. Dept. of Soils and Plant Nutrition).

The morphological and physiological effects of β irradiation on the cells of excised root tips of Pisum sativum and Zea Mays were investigated. The excised tissues were exposed to a 30 mCi ^{90}Sr-^{90}Y source at a distance of 2 mm. The dose to the tissues was increased by extending the exposure time, i.e., 6 min–4.4 Krads to 48 hr–2112 Krads. The morphological and physiological parameters for the investigation were cellular fine structure and respiration respectively. (E.R.B.)

44418 HYDROGEN TRANSFER FROM EXCHANGEABLE TO CARBON-BOUND SITES IN γ-IRRADIATED PROTEINS AND NUCLEIC ACIDS: THE MECHANISM OF RADICAL SATURATION. Riesz, P.; Smitherman, T. C.; Scher, C. D. (National Cancer Inst., Bethseda, Md.). Int. J. Radiat. Biol.; 17: 389-93(1970).

The following experiments were carried out: effect of γ-radiation dose, and temperature on the transfer of tritium from exchangeable to carbon-bound sites in ribonuclease, salmon-sperm DNA, and poly-DL-alanine. Comparison of γ-radiation induced hydrogen transfer with addition of tritiated hydrogen iodide and hydrogen sulphide after γ-radiolysis. It was found that for ribonuclease and poly-DL-alanine, dose saturation was due primarily to radical destruction induced by radiation, and for salmon-sperm DNA, the same was true for an appreciable fluctuation of the radicals. (UK)

44419 DEPENDENCE OF THE U.V. SURVIVAL OF TRANSFORMING DNA ON THE AMOUNT OF DNA UPTAKE PER CELL. Harm, Helga (Univ. of Texas, Dallas). Mol. Gen. Genet.; 107: 71-84(1970).

Ultraviolet irradiation of transforming DNA from Hemophilus influenzae, carrying a streptomycin resistance marker (Sr), results in decreased transforming activity. At high DNA concentration, the "marker survival" is lower than it is at low concentration. The transition from high to low survival occurs at concentrations ranging from 2.5×10^{-3} to 2.5×10^{-2} μg/ml; in this range the probability that transformed cells take up DNA fragments in addition to the marked one increases rapidly. A similar effect of DNA concentration on the percentage of transformants is observed for a mixture of unirradiated and irradiated DNA, where virtually all of the transformants originate from the unirradiated component. This eliminates the possible explanation that the concentration dependence of uv survival of a marker reflects increasing competition for a cellular repair system. It is concluded that the lower marker survival obtained at high DNA concentration involves lethality due to uv lesions present in the additional irradiated DNA taken up by the cell. Thus the steeper marker survival curve is due to the increasing uv dose that the additional DNA necessarily receives when a marker survival curve is being established. Integration of uv lesions rendering a chromosomal DNA strand inviable is suggested by a slight delay in cell multiplication after uptake of irradiated and, to a lesser extent, unirradiated DNA. Acriflavine at a concentration of 0.5 μg/ml enhances the effect of DNA concentration on marker survival. Similarly the number of transformants obtained with unirradiated DNA in the presence of acriflavine is more strongly decreased at high than at low DNA concentration. It is suggested that each event of DNA integration involves a small chance for lethality which is enhanced if the DNA carries uv lesions or if acriflavine is present. (auth)

44420 IN VIVO REPAIR OF UV-IRRADIATION DAMAGE OF SINGLE STRANDED DNA PHAGE ΦX 174. Datta, B.; Poddar, R. K. (Saha Inst. of Nuclear Physics, Calcutta). Mol. Gen. Genet.; 107: 50-7(1970).

When Escherichia coli C cells, infected with uv-irradiated ΦX 174, were allowed to grow in liquid tris-glucose medium at 37°C with aeration, the uv damage of the single stranded (ss) DNA could be repaired to some extent. Such repair was not possible if the irradiated phage were plated immediately on E. coli C in the usual double layer agar method, or if the infected complexes were initially exposed to 0.02 M KCN for 15 min before they were allowed to grow in tris-glucose medium as before. Our results indicate that in order to be repaired, ss DNA containing uv damage must be able to convert itself to a closed, circular, double-stranded replicative form (RF) within the host cells escaping

prior scission. The whole process of repair was found to be dependent on protein synthesis in the infected complexes. (auth)

44421 BIOPHARMACEUTIC ASPECTS OF DEUTERIO-AMPHETAMINE. Foreman, Ronald Louis. Urbana, Ill.; Univ. of Illinois (1969). 139p.

Thesis.

Based upon information concerning the metabolic fate of amphetamine, a model system was developed to investigate a deuterium isotope effect on the enzymatic deamination of amphetamine. The objectives of this study were described as two parts: the synthesis of α-deuterio-1-amphetamine from phenyl-2-propanone oxime and lithium aluminum deuteride, and the determination of protio- and deuterio-1-amphetamine metabolism by a deaminating enzyme known to be present in the 9,000g supernatant fraction of rabbit liver homogenate. Racemic α-deuterio-amphetamine was synthesized in satisfactory yield (46%) by the reduction of phenyl-2-propanone oxime with lithium aluminum deuteride. NMR spectral analysis confirmed that replacement of hydrogen by deuterium was complete and limited to the α-carbon position, since the methine signal of protio-amphetamine was totally absent in high resolution spectra obtained with α-deuterio-dl-amphetamine, while all other NMR spectral characteristics remained unchanged. The identity of α-deuterio-dl-amphetamine is assumed to have been established, while isotopic purity at the α-position appears to be greater than 99 at. %. The optical isomers of deuterioamphetamine were resolved by repeated fractional crystallization of the l-amphetamine-l-bitartrate and d-amphetamine-d-bitartrate diastereomers. Except for the first crystallization, isolated diastereomers from six successive crystallizations were found to possess 97 to 99% optical purity, based on values for pure isomers of protio-amphetamine. The invitro metabolic reaction was found to proceed linearly only during the first 30 to 40 min, after which the rate of protio-l-amphetamine metabolism decreased rapidly. Thus it was apparent that the initial velocity of the reaction was represented by the observed velocity for at least 30 min, but no more than 40 min. Discrepancies with results of earlier reports on amphetamine metabolism are explainable by the different sampling techniques employed in the respective studies, since the generally lower metabolic rates determined by early workers were based on 1 to 2 hr sampling times. Results from stability studies indicated that the amphetamine deaminating enzyme could be stored at −15°C, with only gradual loss of activity, while storage at 0°C resulted in complete loss of activity within 3 to 4 days. Loss of enzyme activity was observed to follow a pseudo first-order rate over a period of 42 days, and the same data indicated an enzyme half-life approximately 37 days under the specified storage conditions. A series of experiments indicated that a significant isotope effect operates in the oxidative deamination of deuterio-1-amphetamine. Under specified conditions, the ratios of apparent rate constants (k_H/k_D) based on initial velocities yield a value of 1.9 ± 0.3. From these results it was concluded that the oxidation of α-deuterio-1-amphetamine at the C−D bond represents, or is at least involved in, the rate limiting process of this sequential drug metabolizing enzyme system. Presumably, formation of the reduced cytochrome P-450 via the hydrogen transport system is not rate-limiting, at least under conditions of this study. Evidence was presented that showed that the rabbit deaminating enzyme exhibited a high degree of selectivity for the levo isomer of both protio- and deuterio-amphetamine. It is interesting to note that the substrate affinity of this deaminating enzyme was more affected by configurational differences (dextro vs levo) than by the effects of deuterium substitution. In fact, it is not unreasonable to suggest that the observed isotope effect (k_H/k_D = 1.9) is primarily a kinetic isotope effect, rather than an effect based upon changes in the enzyme-substrate binding sites. Presumably, the binding site requisites are not appreciably altered by the presence of deuterium, thereby indicating that the α-hydrogen position of amphetamine does not serve as the primary reference point for a binding site with the deaminating enzyme. Although the present study does not provide sufficient data for extrapolation of the results to other species, the determination of an isotope effect in the oxidative deamination of levo-amphetamine by rabbit liver homogenate augurs well for similar studies in other species, including man. Most encouraging perhaps, is that it now appears reasonable to investigate the existence of an isotope effect in the oxidative deamination of dextro-amphetamine by the dog, monkey, and man, as well as other species for which the metabolic pathway of amphetamine has been established as a deaminative process. (Disser. Abst.)

44422 THE REACTION OF OXYGEN WITH RADIATION-INDUCED FREE RADICALS IN DNA AND RELATED COMPOUNDS. Willson, R. L. (Mount Vernon Hospital, Middlesex, Eng.). Int. J. Radiat. Biol.; 17: 349-58(1970).

The transient absorption spectra produced on pulse radiolysis of aqueous solutions of DNA and related biochemicals, saturated with mixtures of nitrous oxide and oxygen, were measured. Spectra observed immediately after the radiation pulse were assigned to the respective adducts formed by the reaction of hydroxyl radicals. Except in the cases of 5-bromouracil, guanylic acid, and DNA, the absorptions decayed rapidly and first order in oxygen. Absolute rate constants for the reaction of oxygen with the adducts of several pyrimidine bases were determined and approach those of diffusion-controlled reactions. Analogous rates of reaction for the related nucleotides and nucleosides are approximately 50% slower. Absolute rate constants for the reaction of oxygen with the hydroxy-adducts of tryptophan and histidine have also been determined. (auth) (UK)

44423 PULSE RADIOLYSIS: AN OXIDATIVE–REDUCTIVE PROBE IN GENERAL BIOCHEMICAL AND ENZYME STUDIES. Adams, G. E.; Cundall, R. B.; Willson, R. L. (Mount Vernon Hospital, Middlesex, Eng.). Biochem. J.; 117: 53p-4(Apr 1970).

The uses of pulse radiolysis for the study of redox processes in biochemical and enzyme systems are briefly indicated. Pulse radiolysis can be used to locate sites of damage in biomolecules or to link certain sites with specific biological activities. Particular note is made of the following: electron attachment to simple disulfides and the observation of the reduction of sulfur bridges in RNA-ASE, papain, and α-chymotrypsin; and hydroxyl radical attack of enzymes at various sites, with special reference to lysozyme. (UK)

44424 PHOTOCHEMICAL REACTIONS IN AMINO ACID RESIDUES AND INACTIVATION OF ENZYMES DURING U. V. IRRADIATION. A REVIEW. Vladimirov, Yu. A.; Roschupkin, D. I.; Fesenko, E. E. (Inst. of Biological Physics, Moscow). Photochem. Photobiol.; 11: 227-46(Apr 1970).

The subject is reviewed under the following headings: photolysis of aromatic amino acid residues; cystine photolysis in proteins; the role of photolysis of amino acid residues in enzyme activation; photoionization of aromatic amino acids under uv radiation; the nature of primary photoproducts of aromatic amino acids; consequent reactions of primary photoproducts and the formation of stable products; and primary photochemical reactions in sulfur containing amino acids. (UK)

44425 NORMAL REPLICATION OF REPAIRED HUMAN DNA. Rasmussen, R. E.; Reisner, B. L.; Painter, R. B. (Univ. of California Medical Center, San Francisco). Int. J. Radiat. Biol.; 17: 285-90(1970).

^{3}H-bromouracil deoxyriboside (^{3}HBrUdR) was used as a DNA precursor in uv-irradiated human diploid cells (WI-38). The demonstration of normal density, tritium-containing, single DNA strands in hybrid DNA, produced during incubation with BrUdR, after initial labeling with ^{3}HBrUdR, constitutes evidence for semi-conservative replication of DNA that has previously undergone repair replication. In cultures that were uv-irradiated with 25 ergs/mm^2, 45% of the DNA that had undergone repair replication subsequently underwent semi-conservative replication. In cultures irradiated with 100 ergs/mm^2, almost none of the DNA that had undergone repair replication subsequently replicated semi-conservatively. It was concluded that the biologically significant function of mammalian DNA repair replication is to repair low levels of damage (normal wear and tear). At high levels, this repair system becomes saturated and incapable of producing functional DNA. (UK)

44426 PHOSPHATE COMPOUND CONTENT OF SKELETAL MUSCLES IN MICE SUBJECTED TO WHOLE-BODY RADIATION. Mehnert, Franz; Waldschmidt, Marianne; Streffer, Christian (Univ., Freiburg i. B.). Strahlentherapie; 139: 506-11(Apr 1970). (In German).

The levels of CP, ATP, ADP, AMP and inorganic phosphate in muscles were determined after whole-body x-irradiation of mice 1 to 14 days after 690 R, 1 to 3 days after 1000 R, 1500 R, 2000 R, 3000 R and 4000 R and 0.5 to 12 hours after 5000 R. The levels of CP were decreased 1 to 3 days after irradiation. This decrease was significant on the second day after all applied doses. On the other hand ATP-levels were not influenced by 690 R and not regularly decreased after higher doses. The levels of ADP and AMP were unchanged after irradiation. Phosphate levels were increased parallel to the decrease in CP-levels; in addition they were also increased 9 to 14 days after 690 R and 2 to 4 hours after 5000 R. (auth)

44427 DEACTIVATION OF SOME HYDROLYTIC ENZYMES IN FISH AFTER RADIATION EXPOSURE. Roushdy, H. M.; El-Kashef, H. S.; Haggag, G. M. (Atomic Energy Establishment, Cairo). Isotope Radiat. Res.; 2: 27-32(Jun 1969).

Total-body γ irradiation of Tilapia sp. at doses of 500 and 1000

rad caused a marked decrease in the hydrolytic activity of both the intestinal and pancreatic amylase. The inhibition was found to be more intensive after the high radiation dose. Although the radiation experiments on fish are scanty and the syndrome involved in the production of radiation damage is not well understood, yet the changes induced by irradiation on amylase activity can be attributed to complex factors, e.g., alteration in the properties of the enzyme itself and/or functional damage developed in its sites of synthesis or place of action. (auth)

44428 QUANTITATIVE HISTOCHEMICAL STUDY OF INTESTINAL MUCOSA AFTER X-IRRADIATION. Galjaard, H.; Buys, J.; van Duuren, M.; Giesen, J. (National Defence Organization TNO, Rijswijk, Netherlands). J. Histochem. Cytochem.; 18: 291-301(1970).

The effect of low doses of x-irradiation (50 to 400 R) on the activity of various enzymes in rat intestinal epithelium has been investigated by histochemical staining methods and quantitative microchemical analyses of crypts and villi dissected from frozen-dried sections. Irradiation had no effect on the activities of enzymes which in nonirradiated animals are present exclusively or mainly in the villus epithelium (aminopeptidase, various phosphatases) or are evenly distributed along the epithelium of crypts and villi (various dehydrogenases). However, nonspecific esterase activity decreased markedly both in crypt epithelium and villus epithelium. This occurred 36 hr after irradiation, independent of the radiation dose. The number of crypt cells with reduced esterase activity and the duration of the effect increased with higher radiation doses. These results were confirmed by quantitative analyses which also showed that esterase activity is 5 times higher in the villus than in the crypt. The remarkable correspondence between the period of reduced esterase activity in the crypt and the period of increased proliferative activity after various radiation doses suggest a relationship between changes in crypt cell population dynamics and esterase activity; the functional consequences for the villus epithelium of changes in the crypt cells after irradiation are discussed. (auth)

44429 X-RAY- AND UV-INDUCED EXCITATION OF ADENINE, THYMINE, AND THE RELATED NUCLEOSIDES AND NUCLEOTIDES IN SOLUTION AT 77°K. Hoennas, P. I.; Steen, H. B. (Norsk Hydro's Inst. for Cancer Research, Oslo). Photochem. Photobiol.; 11: 67-76(Feb 1970).

The light emitted by adenine and thymine and the related nucleosides and nucleotides in ethylene glycol/water glass during irradiation at 77°K with x rays and 270 nm u.v. light was studied. It was found that the same radiative levels were excited by both types of radiation. However, the phosphorescence to fluorescence ratios observed with x rays were considerably enhanced relative to those obtained with u.v. light. This observation was taken to mean that a major fraction of the excitation results from ion recombination, although direct excitation of the triplet manifold as well as intersystem crossing between upper excited levels may have contributed to the enhancement as well. The yields of the x-ray-induced excitation of radiative levels, which were calculated by combining the yields of x-ray-induced emission and the quantum yields observed with u.v.-excitation, corresponded to: $G \geq 4.0$ excitations per 100 eV of dose absorbed in the solute for adenine and $G \geq 1.8$ for thymine. The excitation yields obtained for the nucleosides and nucleotides were somewhat smaller than those observed for the corresponding bases. It was inferred from the yields that a substantial fraction of the dose absorbed in the ribose of the nucleosides was transferred to the radiative levels of the constituent bases. (auth) (UK)

44430 EFFECT OF IONIZING RADIATIONS ON INTESTINAL DISACCHARIDASES IN RATS. Becciolini, A.; Ravina, A. (Univ., Florence). Brit. J. Radiol.; 43: 150-1(Feb 1970).

The enzymes were evaluated in two groups of three adult Sprague–Dawley female rats maintained under identical conditions. One group received ^{60}Co γ irradiation (two exposures of 500 R with a three-day interval) to an abdominal area extending from the pelvis to the diaphram. The second group was controls and all animals were killed 3 days after the second γ-ray exposure and the intestine between the pylorus and the ileocecal valve was tested for activity of alkaline phosphatase, maltase, lactase and intertase. Results indicated that the marked decrease in disaccharidase activity was more affected in the terminal jejunum and proximal ileum, where the enzymes are present in larger quantities. (UK)

44431 EFFECTS OF ^{60}Cr γ-IRRADIATED SUGARS ON THE DEVELOPMENT OF NORMAL AND TUMOROUS TISSUE CULTURES IN VITRO. Jonard, R.; Manant, P.; Schaeverbeke-Sacre, Janine (CNRS, Paris). Radiat. Bot.; 10: 175-89(Apr 1970). (In French).

Solutions of dry sugars irradiated by high doses of ^{60}Co gamma rays (about 5 Mrads) showed alterations. The principal effects observed were as follows: polysaccharide hydrolysis, lowering of pH, appearance of absorption peaks in uv light, about 225 and 280 nm. The same alterations were observed in the case of non-irradiated sugars heated for a long time in an autoclave. Aqueous solutions of dry irradiated sugars inhibited growth of normal and tumorous tissues grown in vitro, and stimulated root formation and their elongation in the explants of Jerusalem artichoke tubers cultured in vitro. Nevertheless, the toxic activity was not lasting. It can be compared to that obtained by use of non-irradiated sugars after heating for a long time in autoclave. Moreover, it was not comparable to the durable effects of a direct irradiation of tissues by x rays, or by a radiomimetic chemical such as a nitrogen mustard. Among many sugar radiolysis products, glyoxal affects plant tissues cultured in vitro in the same way as dry irradiated sugars in aqueous solutions. However the toxic effects observed in these experiments are not absolutely specific of activity of ^{60}Co gamma rays on dry sugars. (auth) (UK)

44432 TRACE METAL BEHAVIOR IN RABBITS AFTER WHOLE-BODY IRRADIATION. Woods, A. H.; O'Bar, P. R.; Waite, Susanne L. (Veterans Administration Hospital, Tucson, Ariz. Univ. of Arizona, Tucson). Int. J. Appl. Radiat. Isotop.; 21: 389-94(Jul 1970).

The behaviour of iron, copper, and zinc in the plasma of rabbits exposed to 1000 R of cobalt radiation has been studied. Control values showed diurnal variations for iron and zinc. Measured against these, there was an initial depression of iron and zinc after radiation, reaching a maximum at about 10 hr after exposure, followed by a rebound of iron to elevated values after 48 hr. Copper increased steadily after radiation to an elevated plateau. Plasma iron clearance rates were also measured, and the relationship of this to the plasma iron behaviour is discussed. (auth) (UK)

44433 FREE RADICALS IN BIOLOGICAL SYSTEMS. Pryor, William A. Sci. Amer.; 223: No. 2, 70-6; 81-3(Aug 1970).

Free radicals are short-lived and highly reactive. They are essential intermediates in many chemical processes. Their role in radiation damage and in aging in biological systems is discussed. (E.R.B.)

44434 EFFECT OF TWO TYPES OF RADIATION ON THE BLOOD SERUM PROTEINS OF DUCKS. Buturlakin, M. S. (Voronezh State Univ., USSR). Veterinariya; 46: 61-2(Feb 1969). (In Russian).

Ultraviolet rays of 0.5 vt/cm^2 increase the content of albumin in the blood serum of ducklings while x-ray with a dose of 800 R reduces the content of β^- and γ-globulin. The combined action of uv and x rays increases the protein fraction in ducklings as compared to the effects of only ionizing radiation. Thus, it was found that uv rays have a very favorable effect on ducklings suffering from exposure to ionizing radiation. (R.V.J.)

44435 DECOMPOSITION OF ALDRIN BY GAMMA RADIATION. Carp, Alan Edward. Lafayette, Ind.; Purdue Univ. (1969). 91p.

Thesis.

The contamination of our food supply by chlorinated hydrocarbon pesticides has been the subject of considerable discussion and legislation in recent years. Research over the past few years has demonstrated that various food processing techniques are capable of decontaminating an affected commodity. Apparently, however, food preservation by γ radiation has not been studied with regard to insecticide decomposition. Consequently, the overall objective of this research was to study the effect of γ radiation on some of the chlorinated hydrocarbon pesticides, with particular reference to the decomposition of aldrin. The aldrin study was divided into two main sections: the effect of γ radiation on aldrin dissolved in organic solvents and the effect of γ radiation on aldrin dissolved in lipids. The general processing method consisted of dissolving the aldrin in the appropriate solvent or lipid at the concentration desired. The samples were subjected to γ radiation in a U. S. Nuclear GR 12, 7500 Ci ^{60}Co irradiation. When desired, the temperature was controlled by suspending the sample tubes in a refrigerant bath at either 0°C or at −196°C. At other times, the temperature was not controlled. The total dose absorbed was controlled by the length of time the samples were irradiated. When dissolved in organic solvents, the decomposition of aldrin increased as the absorbed dose of γ radiation increased from 0.5 Mrad to 6.0 Mrad. The pesticide was protected somewhat from degradation at a concentration of 10 mg/ml. At −196°C the degradation of aldrin was reduced about 21% as compared to samples irradiated at 0°C and at temperatures slightly above room temperatures.

There were indications that mechanisms other than free-radical formation were responsible for some of the breakdown. The amount of aldrin degraded and the number of decomposition products formed by γ radiation varied with the organic solvent in which the pesticide was dissolved. The main decomposition product of the irradiated aldrin-hexane solutions had a gas chromatographic retention value (relative to aldrin) of about 0.71. It appeared to be a monodechlorinated isomer of the parent compound. There was approximately a 65% degradation of aldrin when dissolved in hexane at a concentration of 1 mg/ml and irradiated at 0°C to a total absorbed dose of 6.0 Mrad. On the other hand, it made very little difference on the decomposition of the aldrin whether the pesticide was irradiated in a corn oil or lard system, was packed in an atmosphere of air or nitrogen, or was stored at room temperature or at −20°C after irradiation. The only factor that appeared to have any practical significance in altering the amounts of the decomposition products formed or the amount of undegraded aldrin remaining in the lipid sample was the temperature at which irradiation was accomplished. On the average, the aldrin was degraded about 20% when the lipid solutions were irradiated at a concentration of 1 mg per ml at an absorbed dose of 6.0 Mrad. (Diss. Abstr.)

44436 ELECTRON-SPIN-RESONANCE SPECTROSCOPY OF RADIATION INDUCED FREE RADICALS IN IRRADIATED SINGLE CRYSTALS OF THYMINE MONOHYDRATE. Huettermann, Juergen (Institut fuer Strahlenbiologie, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 17: 249-59(1970).

The molecular structures of free radicals formed in irradiated single crystals of thymine monohydrate were investigated by ESR spectroscopy. Two different types of radicals were observed, their relative contribution in the spectra depending on the experimental conditions. One is the previously known 5,6-dihydro-5-thymyl radical, the conformation of which is discussed briefly. It is proposed that the additional radical is formed by loss of a hydrogen atom from the methyl group, leaving an unpaired electron in a $2p_z$ orbital of the methyl carbon atom. The hyperfine spectrum of this radical originates from the interaction of the unpaired electron with the two remaining α-protons of the methyl group and, via resonance delocalization, with the α-proton attached to carbon atom C_6 of the thymine molecule. The hyperfine tensors of these couplings are given together with the g-tensor of this radical. (auth) (UK)

44437 RADIATION SENSITIVITY OF HAEMOPHILUS INFLUENZAE: A COMPOSITE RESPONSE. Barnhart, B. J.; Cox, S. H. (Los Alamos Scientific Lab., N. Mex.). J. Bacteriol.; 103: 9-15(Jul 1970).

The survival of ultraviolet uv-irradiated cultures of Haemophilus influenzae Rd is determined by at least two responses: excision-repair ability and uv-induced cell lysis. An uv-resistant mutant, BC200, has the same capabilites as the wild type, Rd, for excising dimers but does not exhibit lysis. Lytic response is dose-dependent. Relative to the wild type, a lower dose of uv causes lysis of a uv-sensitive mutant, BC100, which is incapable of excising thymine dimers. A lytic protein is present in cultures undergoing lysis. Synthesis of this protein is initiated 45 to 60 min after irradiation. Lysis appears to be caused by derepression of a defective prophage that codes for an endolysin-like lytic enzyme. (auth)

44438 SYNTHETIC AND HYDROLYTIC ENZYMES OF GLYCOGEN IN THE NORMAL AND THE IRRADIATED RAT BRAIN. Ibrahim, M. Z. M.; Atlan, H.; Miquel, J.; Castellani, P. (American Univ., Beirut. Ames Research Center, Moffett Field, Calif.). Radiat. Res.; 43: 341-56(Aug 1970).

Eight-week-old rats were irradiated with x- and γ rays, and their brains were studied histochemically. They showed a transient increase in their glycogen content. The lowest exposure capable of producing a detectable increase in glycogen was 500 R. Visible accumulation of glycogen started approximately 6 to 8 hr postirradiation and reached a maximum at 18 to 48 hr. A simultaneous increase in phosphorylase and phosphorylase plus branching enzyme activity was recorded. This was mild initially but gradually became more prominent. The branching enzyme and some oxidoreductive enzymes were apparently unaffected except 6-phosphogluconate dehydrogenase, which was slightly increased. The activities of the enzymes glycogen synthetase and glyceraldehyde 3-phosphate dehydrogenase were unaltered in the irradiated brains. Glycogen synthetase activity even seemed to be diminished below normal levels 24 hr post-irradiation. Hexokinase reaction was slightly increased about 2 hr post-irradiation. The changes in phosphorylase activity and glycogen content are probably initiated by a transient hypoxia at the molecular level causing diminished aerobic as well as anaerobic glycolysis. A simultaneous increase in the glucose level of blood and brain probably plays a major role in raising the glycogen content. The phosphorylase reaction emerged from this study as the most sensitive histochemical parameter of radiation injury. (auth)

44439 ISOLATION AND CHARACTERIZATION OF 2-(β,D-GLUCOPYRANOSYL)-4-ALANYL-3-ISOXAZOLIN-5-ONE: A SECOND UV-SENSITIVE HETEROCYCLIC α-AMINO ACID FROM PISUM SATIVUM L. (Lambein, F.; Van Parijs, R. (Ghent State Univ.). Biochem. Biophys. Res. Commun.; 40: 557-64(11 Aug 1970).

In addition to 2-alanyl-3-isoxazolin-5-one (I), another uv-sensitive heterocyclic α-amino acid (III) was isolated and purified from pea seedlings. Some properties of III are compared with those of synthetic isoxazolinone derivatives and with those of I. The chemical structure was analyzed by chemical methods and by spectroscopy. The structure was found to be: 2-(β,D-glucopyranosyl)-4-alanyl-3-isoxazolin-5-one. (auth)

44440 RADIOLYTIC CLEAVAGE OF THE PEPTIDE MAIN-CHAIN IN CONCENTRATED AQUEOUS SOLUTION: ENERGY LEVEL OF EXCITED-MOLECULE INTERMEDIATES. Rodgers, Michael A. J.; Sokol, Harvey A.; Garrison, Warren M. (Univ. of California, Berkeley). Biochem. Biophys. Res. Commun.; 40: 622-7(11 Aug 1970).

The γ-radiolysis of oxygen-free solutions of simple peptides such as N-acetylglycine and N-acetylalanine at concentrations above 0.1 M leads to formation of excited species $RCONHCHR_2$*. Reactions of these excited-molecule intermediates lead to cleavage of the peptide main-chain with formation of amide and fatty acid functions. Through use of a series of aromatic second-solutes as excitation quenchers it is possible to assign the energy level of $RCONHCHR_2$* at about 3.5 eV. (auth)

44441 DENATURATION OF DNA AFTER X-IRRADIATION IN VITRO. Das Gupta, Ranjit; Mitra, Sankar (Bose Inst., Calcutta). Biochem. Biophys. Res. Commun.; 40: 793-9 (24 Aug 1970).

X irradiation of Escherichia coli DNA caused partial strand-separation as judged by susceptibility of the DNA to nuclease specific for single-stranded DNA, namely an endonuclease from Neurospora crassa and exonuclease I of E. coli. The elution profile of x-irradiated DNA from hydroxyapatite column showed that single-stranded fragments were produced. These fragments had a sedimentation coefficient of 3 to 4s corresponding to a length of about 250 nucleotides. (auth)

Immunology

Refer also to abstract 44646.

44442 ROLE OF THE THYMUS IN TOLERANCE. IX. INHIBITION OF EXPERIMENTAL AUTOALLERGIC ENCEPHALOMYELITIS BY INTRATHYMIC INJECTION OF ENCEPHALITOGEN. Ellison, George W.; Waksman, Byron H. (Yale Univ., New Haven). J. Immunol.; 105: 322-6(Aug 1970).

Adult rats received 750 or 800 R of whole-body x irradiation with simultaneous thymic or splenic shielding and immediately thereafter were given intrathymic, intrasplenic, or intraperitoneal injections of suspensions of rat spinal cord or acid-extracted rat cord encephalitogen. Three weeks later the animals were challenged with the corresponding antigen in Freund's adjuvant. Animals receiving intrathymic encephalitogenic material showed a slight but definite decrease in the severity of experimental autoallergic encephalomyelitis (EAE). The acid-extracted encephalitogen showed four components after filtration through Sephadex G-200. Electrophoresis on 5% acrylamide gel in the presence of 8 M urea revealed at least four cathodally migrating and four anodally migrating bands. (auth)

44443 IMMUNOSUPPRESSIVE EFFECT OF SERUM FROM CBA MICE MADE TOLERANT BY THE SUPERNATANT FROM ULTRACENTRIFUGED BOVINE γ GLOBULIN. Tong, James L.; Boose, Dorothy (Veterans Administration Hospital, Denver). J. Immunol.; 105: 426-30(Aug 1970).

In studies on tolerance to bovine γ globulin (BGG) induced in CBA mice by injection of the supernatant fraction of ultracentrifuged BGG, tolerance was not terminated by adoptive transfer of 10^8 spleen cells from normal or immune mice. Moreover, the serum of tolerant mice passively transferred to normal mice inhibited the immune response to BGG. This inhibition was attributed to the presence of specific antibody in the serum of tolerant mice. (auth)

44444 FETAL ANTIGEN CAPABLE OF INDUCING TRANSPLANTATION IMMUNITY AGAINST SV40 HAMSTER TUMOR

CELLS. Coggin, J. H.; Ambrose, K. R.; Anderson, N. G. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). J. Immunol.; 105: 524-6(Aug 1970).

Using x-irradiated hamster and mouse fetal cells collected at different times during gestation, the existence of fetal antigen capable of inducing transplantation immunity against SV40 hamster tumor cells was determined. It was found that both hamster and mouse fetal cells possessed an equivalent or at least cross reactive antigen to that present in SV40 hamster tumor cells. The data also suggested that transplantation-like antigens were present in the hamster fetus during embryogenesis, but were not expressed during the terminal stages of gestation. (E.R.B.)

44445 VARIATIONS IN RABBIT ANTIMOUSE LYMPHOCYTE SERA CAUSED BY LYMPHOCYTES OF DIFFERING ORIGINS IN THE IMMUNIZING INOCULA. Miller, Joshua; Tanner, Dorothy; Cohn, Roy (Stanford Univ., Calif.). Transplantation; 9: 352-65(Apr 1970).

Rabbit antisera against mouse lymph node (ALS), thymus, and immune lymph node (ALS-immune) were tested by skin allograft survival with and without x irradiation, by H-2 hemagglutination, and by leukoagglutination and absorption. Whole-body x irradiation with 1,000 rads and shielding of spleen, upper thoracic contents, or femur markedly enhanced the effects of two i.p. injections of 0.1 ml of antiserum. The mean survival times of allografts were between 12 and 22 days using either the antisera or x irradiation and shielding separately. There was prolongation up to 70 days when the two were combined, without increasing mortality. Thoracic and spleen groups brought out differences in the effects of ALS and antithymocyte serum on first-set allograft survival. ALS-immune had the most marked effect on third-set allograft prolongation and produced the most profound decrease in H-2 hemagglutinin responses. Leukoagglutination and absorption of the sera also showed differences, suggesting that antigenic differences between lymph node and thymus cell populations in the immunizing inocula could elicit different antibodies. (auth)

44446 OCCURRENCE OF TWO TYPES OF CYTOTOXIC LYMPHOID CELLS IN MICE IMMUNISED WITH ALLOGENEIC TUMOUR CELLS. Denham, Sylvia; Grant, C. K.; Hall, J. G.; Alexander, P. (Chester Beatty Research Inst., Surrey, Eng.). Transplantation; 9: 366-82(Apr 1970).

Spleen cells from C57BL mice immunized once with L5178Y lymphoma cells, which are of DBA/2 genotype, were assayed for cytotoxicity by measuring their effect on the growth of L5178Y cells in vitro. Two populations of cytotoxic spleen cells were distinguished: those found predominantly 6 to 12 days following immunization; and those found 14 days and later following immunization. The cytotoxic activity of the early cells was relatively radioresistant and was not affected by drugs that inhibit nucleic acid synthesis. These early cells resemble those found in lumph from draining nodes, which are cytotoxic only 4 to 8 days after immunization. Spleen cells taken from mice and rats 21 days after immunization lost cytotoxic activity by exposure to 500 R of x rays and to mitomycin C, actinomycin D, and potassium cyanide. Removal of macrophages did not reduce the cytotoxicity of either class of spleen cell. Cytotoxicity was unaffected by the addition of a source of complement, but this does not exclude the participation of some complement components (which are synthesised by spleen cells). By following the release of ^{51}Cr, it was shown that the L5178Y cells lysed sooner after the addition of spleen cells taken at 7 days, as compared to 21 days, after immunization. The 21-day spleen cells acquired some of the properties of 7-day spleen cells (such as radioresistance) after exposure to target cells for 10 hr. The hypothesis is advanced that the cells responsible for cytotoxicity in spleens at 7 days after immunization are immunoblasts (i.e., large pyroninophilic cells), as had earlier been shown to be the case for cells in the lymph from immunized donors. These cells, it is postulated, are directly cytotoxic, possibly because they already possess the machinery for the synthesis of antibody. The cells found in spleen 21 days after immunization are only potentially cyctotoxic and become transformed—hence their radiosensitivity—by contact with target cell antigen into the actual cytotoxic cells, which are presumably immunoblasts. (auth)

44447 EFFECTS OF ALLOGENIC LYMPHOCYTES ON INDUCTION OF TOLERANCE IN ANTILYMPHOCYTE GLOBULIN-TREATED X-IRRADIATED RATS. Chatterjee, S. N.; Anderson, N. F.; Bonfiglio, M.; James, K.; Woodruff, M. F. A. (Univ. of Edinburgh). Transplantation; 10: 197-9(Aug 1970).

The induction of immunological tolerance to skin grafts was experimentally demonstrated in antilymphocyte-globulin treated rats. The survival time of the allografts was increased by the administration of whole-body x irradiation in combination with intravenous injections of viable allogeneic lymphocytes. However, the variance in survival time within a given group was so great that the differences between groups were not statistically significant. (E.R.B.)

44448 ELECTROPHORETICALLY HOMOGENEOUS ANTIBODY SYNTHESIZED BY SPLEEN FOCI OF IRRADIATED REPOPULATED MICE. Luzzati, A. L.; Tosi, R. M.; Carbonara, A. O. (Univ., Turin). J. Exp. Med.; 132: 199-210(1 Aug 1970).

10^6 splenocytes from primed donors were injected, together with sheep erythrocytes (SRBC), into x-irradiated syngeneic mice. Eight days later the spleens were excised and cut into small fragments, keeping track of their location in the organ. Each fragment was cultured individually for 24 hr in the presence of ^{14}C amino acids and the culture fluids were assayed for antibody activity. The antibody-producing fragments were found to be clustered in few restricted areas (foci) surrounded by negative tissue. The anti-SRBC antibody from single foci was purified by absorption on stroma followed by acid elution. Thereafter, it was subjected to electrophoresis and immunoelectrophoresis. The radioautography of the runs showed a considerable degree of homogeneity. Distinct and sharp spikes were localized in the β and γ region. The pattern of each focus is unique from the point of view of the number of spikes and their mobility. Eluates obtained from many pooled fragments gave a broad radioactive smear in the $\beta-\gamma$ region. Many foci synthesized antibody migrating as a single band. This homogeneous protein is probably the product of a clone of cells homogeneously differentiated. However, some foci producing two and probably more antibody bands were also encountered. Two interpretations of the finding can be given. Either more than one precursor may participate in the formation of a focus or a differentiation switch may occur during the clonal expansion. (auth)

44449 SYNERGISM OF THYMUS AND BONE MARROW IN THE PRODUCTION OF GRAFT-VERSUS-HOST SPLENOMEGALY IN X-IRRADIATED HOSTS. Hilgard, Henry R. (Naval Medical Research Inst., Bethesda, Md.). J. Exp. Med.; 132: 317-28(1 Aug 1970).

Graft-versus-host splenomegaly may be elicited from 500 R x-irradiated F_1 hybrid hosts if the hosts are injected with bone marrow cells and thymus cells from parental strain donors. Cells from thymus only or bone marrow only will not elicit graft-versus-host splenomegaly in these hosts. In this requirement for cells from both sources, the bone marrow cells play a nonimmunologic, proliferative role in the splenomegaly, and the thymus cells carry out the immunologic attack. Thus the mechanism of this synergism is quite different from that reported for the humoral immune response to sheep erythrocytes in which both thymus and marrow interact in the production of the specific immunologic response itself. (auth)

44450 ANTIGEN-SPECIFIC SYNERGISM IN THE IMMUNE RESPONSE OF IRRADIATED MICE GIVEN MARROW CELLS AND PERITONEAL CAVITY CELLS OR EXTRACTS. Kennedy, James C.; Treadwell, Perry E.; Lennox, Edwin S. (Salk Inst. for Biological Studies, San Diego, Calif. Queen's Univ., Kingston, Ont.). J. Exp. Med.; 132: 353-67(1 Aug 1970).

A synergistic immune response to foreign erythrocytes may be induced in heavily irradiated mice injected with a mixture of isologous cells obtained from marrow and from the peritoneal cavity. Under appropriate conditions, homologous or heterologous peritoneal cavity cells, heat-killed cells, or cellfree extracts made from such cells are also effective. The activity of the peritoneal cavity cells or extracts is antigen-specific, in the sense that cells or extracts obtained from animals previously immunized with the test antigen produce much stronger synergistic effects than do cells from animals immunized with some other antigen; however, the peritoneal cavity cells or extracts are not immunogenic when tested in primed animals. The marrow cells, demonstrated to contain precursors of the antibody-forming cells produced during this synergistic immune response, also show a form of antigen-specificity. (auth)

44451 SOME PHYSICAL AND RADIOBIOLOGICAL PROPERTIES OF IMMUNOLOGICALLY REACTIVE MOUSE SPLEEN CELLS. Osoba, David (Univ. of Toronto. Ontario Cancer Inst., Toronto). J. Exp. Med.; 132: 368-83(1 Aug 1970).

Three classes of immunologically reactive cells, differing only slightly in size from each other, are required for the production of hemolysin-forming cells in culture. The three classes of cells can be detected in the normal mouse spleen by the combined use of rosette formation, velocity sedimentation, and irradiation. One class of cells (peak sedimentation velocity, 3.2 mm per hr) forms rosettes. The capacity of these cells to participate in immune responses to foreign erythrocytes is inhibited by relatively low doses of irradiation. These cells may be the immediate precursors of hemolysin-forming cells. A second class of cells (peak sedi-

mentation velocity, 3.6 mm per hr) facilitates the production of hemolysin-forming cells by small numbers of normal spleen cells. Their facilitative activity is resistant to a relatively large dose of radiation. They do not form rosettes. The requirement of a third class of cells was deduced from the results of mixing experiments. Neither rosette-forming cells nor spleen cells largely depleted of rosette-forming cells could give rise to hemolysin-forming cells when cultured either alone or in the presence of large numbers of heavily irradiated cells. However, when rosette-forming cells, cells depleted of rosette-forming cells, and heavily irradiated cells were mixed together, hemolysin-forming cells were produced. The peak responses were found in fractions sedimenting at 4 mm per hr. Thus, it is suggested that these fractions contain a third class of cells. This class of cells does not form rosettes, but its function is inhibited by relatively low doses of radiation. (auth)

44452 ONTOGENY OF CELL POPULATIONS REQUIRED FOR IMMUNOCOMPETENCE. Brody, Thomas; Papermaster, Ben W. (Univ. of California, Berkeley. Roswell Park Memorial Inst., Buffalo). J. Immunol.; 105: 139-45(Jul 1970).

Differentiation from cellular progenitors of two cell populations required for the immune response to sheep erythrocyte antigens was studied. The receptor-bearing population differentiates from bone marrow progenitors much more rapidly than the peripheral thymic population. The differentiation from bone marrow progenitors of the cells with receptors for antigen is completely independent of thymus, while the differentiation of the peripheral thymic population is dependent upon thymus function. Peyer's patches may not be considered solely as primary lymphoid organs. Peyer's patches in adults have all the cell populations required for immunocompetence. In addition, Peyer's patches cannot be considered the initial source in the neonatal period of the cells with receptors for antigen, because these cells are present in the prenatal period in fetal liver. (auth)

44453 SPECIFIC INHIBITION OF TUMOR CELL DNA SYNTHESIS IN VITRO BY LYMPHOCYTES FROM PERITONEAL EXUDATE OF IMMUNIZED SYNGENEIC GUINEA PIGS. Oppenheim, Joost J.; Zbar, Berton; Rapp, Herbert (National Institutes of Health, Bethesda, Md.). Proc. Nat. Acad. Sci. U. S. A.; 66: 1119-26(Aug 1970).

Tumor immunity to a transplantable diethylnitrosamine-induced hepatoma in inbred guinea pigs has been found to be immunologically specific and cell mediated. We have investigated this cellular immunity using a quantitative, reproducible, and simple assay based on the ability of leucocytes to inhibit the incorporation of tritiated thymidine (TdR^3H) by tumor cells. Tumor cell suspensions were obtained from the ascites form or tissue culture monolayers of the hepatoma. Cells from the peritoneal exudate of immunized guinea pigs inhibited tritiated thymidine uptake by tumor target cells to a significantly greater degree than cells from the peritoneal exudate of unimmunized animals. Immune lymph node, peripheral blood, and spleen leucocytes were not inhibitory. The assay was sufficiently sensitive to detect relatively weak tumor immunity. The in vitro inhibition was correlated directly with the presence of delayed hypersensitivity and/or inhibition of tumor cell growth in local passive transfer studies. Irradiation of peritoneal exudate cells (3000 R) blocked their inhibitory effects on tumor cells. Fractionation of the peritoneal exudate cells by centrifugation in zones of bovine serum albumin of different density also revealed the lymphocytes to be responsible for the specific inhibitory effects whereas macrophages inhibited in an immunologically nonspecific fashion. (auth)

Ecology

Refer also to abstracts 44121, 44123, 44473, 44495, 44508, 44509, 44514, and 45899.

44454 (BMI-171-128) RESEARCH PROGRAM ON MARINE ECOLOGY AND OCEANOGRAPHY, AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1968-June 30, 1969. Amchitka Bioenvironmental Program. Burgner, R. L.; Chew, K. K.; (and others) (Battelle Memorial Inst., Columbus, Ohio). Sep 1969. Contract AT(26-1)-171. 92p. Dep. CFSTI.

Ecological research on coastal and intertidal marine environments of Amchitka Island were continued through June, 1969. The study is part of the bioenvironmental analyses performed for feasibility decisions and to provide baseline information for the hazard effects evaluations relative to nuclear testing on the Island. This segment of the program was begun in 1967 and has emphasized habitats; species composition, distribution, and population levels; food chain kinetics; and life histories of commercially important and other selected species. Activities during FY 1969 included the continued definition of intertidal habitats. Seasonal aspects of invertebrate populations in intertidal areas were correlated with vertical locations and algal zones. Recolonization and succession studies during the fall and winter revealed that gastropods (Littorina sp. and Acanaea sp.) and some algal species became established on rocks in several intertidal study areas but the rate of succession was related to vertical contour and to general rock location. Intertidal marine algal communities were determined to occur in three zones at approximately -1, +0.5, and 2 feet. Common species were stable in abundance while less abundant species were more variable seasonally. The abundance of amphipods, diptera (seaweed flies), and nematodes was estimated in several locations from core samples of recently beached algae (seaweed). High concentrations of amphipods were generally found in algae recently washed ashore, while diptera and nematodes were more abundant in older partially decomposed algae. Marine zooplankton life history, compositional and seasonal abundance studies were continued also. Ten families of amphipods, one Mysid genus, 3 major groups of copepods (Calanoids, Cytopoida, and Harpacticoida), and 11 species of diatoms were collected and studied. Diatoms were the principal plankters deposited on settling boxes in Constantine Harbor during the fall and winter. Other animals and plants were abundant on the plates in the spring but diatoms continued to be dominant. An array of fishing methods yielded 12 fish species not previously captured in this study. Four of these were new to Amchitka. Small crustaceans (i.e., amphipods and Mysids) were common items of fish diets but seasonal variations were noted. The only commercially important subtidal crustacean taken during the period was the tanner crab (Chionecetes sp.). All were juveniles and appeared restricted in distribution. The most abundant noncommercially important invertebrate species were the sea urchin (Strongylocentrotus drobachiensis) in subtidal areas but the starfish (Legasterios sp.) was captured frequently also in shallower subtidal areas. (auth)

44455 (HASL-217, pp I.2-8) VALUES OF ^{90}Sr IN VERTEBRAE AND IN FEMORAL DIAPHYSIS OF ADULTS IN CZECHOSLOVAKIA IN 1968. Brezik, Zdenek (Vyzkumny Ustav Hygieny Zareni, Prague (Czechoslovakia)).

From Fallout Program Quarterly Summary Report.

The content of ^{90}Sr was measured in bone samples collected from 54 human adults in Czechoslovakia during 1968. From the values of ^{90}Sr(p Ci/g Ca) determined in specimens of vertebrae and femoral diaphysis the ratio of vertebrae/femoral diaphysis was calculated. (C.H.)

44456 (HASL-217, pp II.1-215) HASL FALLOUT PROGRAM DATA. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From Fallout Program Quarterly Summary Report.

Data are presented on the content ^{90}Sr in the human diet in New York city and San Francisco during the third quarter of 1969. The data are based on measurements of ^{90}Sr content in 19 representative classes of food. Data are presented on the content of ^{89}Sr and ^{90}Sr in samples of dry fallout and precipitation collected at various stations throughout the United States, over the North Atlantic Ocean, and other selected sites during 1969. Filters used for collecting samples from surface air and the lower stratosphere (12 to 19 km altitude) were measured for total γ activity and analyzed for a number of fission and activation product radioisotopes. Data are given on the content of ^{141}Ce, ^{144}Ce, ^{55}Fe, ^{210}Pb, ^{210}Po, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{89}Sr, ^{90}Sr, and ^{95}Zr in samples collected during the last half of 1968 and the first half of 1969. Balloon borne filtering devices were used to collect samples of nuclear debris in the stratosphere at altitudes from 24 to 41 km. The filters were counted for total γ activity and analyzed for specific radioisotopes. Data are given on the content of ^{144}Ce, ^{239}Pu, ^{89}Sr, ^{90}Sr, and ^{95}Zr in samples collected during 1968 and through April 1969. The content of ^{55}Fe, produced in large quantities during the 1961 and 1962 USSR test series, and ^{238}Pu, disseminated in the upper stratosphere by the reentry burnup of a SNAP-9A power source in April 1964, were also measured. (C.H.)

44457 (HASL-217, pp III.2-13) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND MEASUREMENTS ON SAMPLES FROM FIJI AND RAROTONGA. Quarterly Report, January-March 1969. (National Radiation Lab., Christchurch (New Zealand)). (NRL-F-34).

From Fallout Program Quarterly Summary Report.

Results of routine monitoring of fallout in New Zealand during the first quarter of 1968 are presented. The total β activity in samples of atmosphere, rain, and milk and the content of ^{137}Cs in milk, ^{89}Sr in rain water, and ^{90}Sr in milk and rain water were measured. (C.H.)

44458 (HASL-217, pp III.20-3) ^{137}Cs IN VARIOUS CHICAGO FOODS (COLLECTION MONTH OCTOBER 1969). Brar, S. S.; Nelson, D. M. (Argonne National Lab., Ill.).

From Fallout Program Quarterly Summary Report.

Since April, 1961, the ^{137}Cs and potassium content of the Chicago portion of Tri-City Diet Sampling Program was determined in bulk food samples by γ ray spectrometry using a 4" × 4" NaI (Tl) crystal. The individual food components were counted for a minimum of 100 minutes, and from these measurements composite daily and yearly food intakes were obtained. Cesium-137 activity in food, now, is an order of magnitude lower than it was a few years ago; consequently, a new procedure for these measurements was adopted in order to improve accuracy. The same variety of foods (all fresh vegetables and all fresh fruits) are composited before measurement, and the samples are counted a minimum of 400 minutes. The results of October, 1969, quarter are tabulated. (auth)

Genetics and Cytogenetics

Refer also to abstracts 44385–44387, 44420, and 44627.

44459 GENETICS OF CITRIC ACID PRODUCING STRAINS OF ASPERGILLUS NIGER. PART II. CITRIC ACID SYNTHESIS BY AUXOTROPHIC MUTANTS OF A. NIGER INDUCED WITH UV. Ilczuk, Z. (Maria Curie Sklodowska Univ., Lublin, Poland). Nahrung; 14: 97-105(1970). (In German).

Thirty-eight auxotrophic mutants of A. niger of different colored spores were produced from 4 parent strains by uv irradiation. Mutants required for their growth: niacin, folic acid, p-amino benzoic acid, thiamine, pyridoxine, leucine, and adenine. All auxotropic strains of A. niger preserved their ability of growth and citric acid synthesis on fermentation medium from beet molasses. In general they produced less mass of the mycelium than their parent prototrophic strains on this medium. In some cases absolute concentrations of citric acid produced by auxotrophic strains of A. niger were higher than in the samples fermented by prototrophs. In general, the ratio of citric acid concentration to unit of the mycelial mass was higher in auxotrophic mutants than in prototrophs. Citric acid production by previous methods is more economical. The molasses contained relatively high concentrations of biologically active substances, which furnish the requirements of auxotrophic mutants for their growth and synthesis of citric acid. Thus, application of auxotrophic mutants for industrial production of citric acid does not need changes of technology. (auth)

44460 RADIO-INDUCED MUTATIONS IN PLANTS GROWN IN SENEGAL. Sene, D. (Bureau des Affaires Scientifiques, Dakar, Senegal). pp 149-50 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Mutations were induced by x irradiation in three species of plants: rice; ground nut; and Pennisetum typhoides. (tr-auth)

44461 A COMPARISON OF MUTAGENICITY OF 14 MeV FAST NEUTRONS ON PRIMORDIAL GERM CELLS AMONG FIVE DIFFERENT X-RAY SENSITIVE SILKWORM STRAINS. Murakami, A. (National Inst. of Genetics, Misima, Japan). Int. J. Radiat. Biol.; 17: 479-82(1970).

The RBE value was defined as the ratio of mutation rate of neutrons (910 rads) to that of x rays (970 rads). The radiation-induced mutation rate was higher for male than female germ cells. Strain differences in mutation rate were found for x rays and neutrons, and strains sensitive to x rays were sensitive to neutrons and vice versa. The average mutation rates at two loci in germ cells of the most sensitive strain, Sekko, were 31.7×10^{-7} for x rays and 14.4×10^{-7} for neutrons, while for the least sensitive strain, Tokuishin, they are 3.0×10^{-7} for x rays and 3.8×10^{-7} for neutrons. The same trends were observed in male and female cells, but were less pronounced with neutrons than x rays. There was a significant difference in mutation rates between Sekko and Tokuishin regardless of radiation quality. The results were interpreted on the assumption that a radiation resistant strain may be able to repair radiation-induced premutational damage whereas a sensitive strain cannot, and that neutron damage repair is not as great as that of x-ray damage. (UK)

44462 DIFFERENTIAL TRANSMISSION OF TRANSLOCATIONS INDUCED IN SPERMATOGONIA OF MICE BY IRRADIATION. Ford, C. E.; Searle, A. G.; Evans, E. P.; West, B. Jean (Medical Research Council, Harwell, Eng.). Cytogenetics; 8: 447-70 (1969).

The hindquarters of two batches each of five young adult male mice were exposed to an acute dose of 1,200 R of 250 kV x rays in two fractions of 600 R, separated by a period of eight weeks. Means of 41.2% and 32.6% spermatocytes with one or more multivalent configuration were found when the mice were killed 13 to 18 and 59 weeks, respectively, after the second dose. The multivalent configurations were attributed to reciprocal translocations induced in spermatogonia. Other types of chromosomal abnormality were rare. 150 sons were tested for semi-sterility and subsequently examined cytologically. Five were found to be translocation heterozygotes. One other was cytologically normal but nevertheless exhibited semi-sterility and transmitted this character to some of its descendents. The frequencies of spermatocytes with various numbers and types of multivalents were used to estimate the proportions of sperm with normal, balanced translocated and unbalanced haploid genomes, and hence the expected frequencies of zygotes with abnormal karyotypes. The expected frequency of semi-steriles (or translocation heterozygotes) in the progeny proved to be about twice as great as that observed in parallel genetic experiments and in the sons of the irradiated males. Expected dominant lethals were also about twice as frequent as observed by other workers. Whatever assumptions are made regarding the distribution of chiasmata in the multivalents and their manner of disjunction, the observed frequencies of translocation heterozygotes or dominant lethals or both are much less than the expected frequencies. The evidence is considered to favor a selective process operating on diploid rather than haploid genomes but perhaps taking effect on the haploid spermatids or sperm. (auth)

44463 RADIATIONS IN HUMAN GENETICS. Hoyos, Jorge Meneses. Medicina (Mex.); 49: 32-5(1969). (In Spanish).

Congenital malformations and mutations appear in the human species without apparent cause, hence the great difficulty in determining exactly the role of radiations in their production. All investigations with respect to this should be based on statistical methods. (tr-auth)

44464 INDUCTION BY X-RAYS OF ISOCHROMOSOMES IN THE GERM CELLS OF DROSOPHILA MELANOGASTER MALES. Leigh, B.; Sobels, F. H. (Univ., Leiden). Genen Phaenen; 13: No. 2, 9-10(Nov 1969).

Males flies were x-irradiated and mated to females carrying isochromosomes. The exceptional progeny obtained consisted mainly of triploids or carried newly induced isochromosomes. In the unirradiated controls no spontaneously formed new isochromosomes were recovered. The most sensitive germ cell stages for the induction of new isochromosomes were spermatocytes and possibly spermatids. It is suggested that isochromosomes originate by a chromatid-type exchange with two breaks, one on each side of the centromere. (H.L.W.)

44465 INDUCTION OF RECESSIVE LETHAL MUTATIONS UNDER WEIGHTLESSNESS IN THE NEUROSPORA EXPERIMENT ON THE BIOSATELLITE II MISSION. de Serres, F. J.; Webber, B. B. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 43: 452-9(Aug 1970).

Samples of asexual spores of a two-component heterokaryon of Neurospora crassa collected on Millipore filters were flown on Biosatellite II in September 1967 to evaluate the genetic effects of radiation in combination with weightlessness. Preliminary genetic analyses for cellular inactivation and the overall induction of recessive lethal mutations in the ad-3 region reported previously [F. J. de Serres and Webber, B. B., Bioscience 18, 590 to 595 (1968)] indicated that the effects of radiation under weightlessness were not different from those in earth-based experiments. The genetic analysis of the ad-3 mutations in the flight and ground control samples is now complete, and comparisons were made between the dose-response curves for the different classes of ad-3 mutations, showing that there is no effect of weightlessness on the spectrum of radiation-induced recessive lethal mutations. These data confirm the negative results obtained with dormant spores flown on Gemini XI. (auth)

44466 EFFECT OF X-IRRADIATION ON GENE FUNCTION IN BACTERIOPHAGE T4. Wallace, Susan S.; Van Dyke, James G. (Cornell Univ., New York. New York Univ., N. Y.). Radiat. Res.; 43: 379-92(Aug 1970).

The effect of x irradiation on gene function in bacteriophage T4 was examined using amber mutants for gene complementation. Early functions tested were less sensitive to x rays than late functions. Both early and late functions were stabilized in chloramphenicol-pretreated complexes, but early functions were stabilized to a much greater extent. A model for phage radiation inactivation is proposed that relates the survival of gene function to the survival of the intact bacteriophage. (auth)

Health Physics and Safety

Radioactive Contamination and Decontamination

Refer also to abstracts 44157, 44454–44458, and 44612.

44467 ^{45}Ca ACTIVITY IN THE BODY OF LIVING PIGS. Molnar, S. (Univ., Goettingen, Ger.). Z. Tierphysiol.; Tierernaehr. Futtermittelk.; 26: 59-61(Feb 1970). (In German).

In two adult sows the specific activity of ^{45}Ca in vertebra of the tail was measured. From this the specific activity of ^{45}Ca in the total carcass was calculated. When the animals were slaughtered, the specific activity of ^{45}Ca of the animals was determined and compared to the calculated results. (auth)

44468 ROLE OF A BIOLOGICAL FILTER WITH SEDIMENTATION TANKS IN THE DECONTAMINATION OF SEWAGE FROM RADIOACTIVE ISOTOPES. Il'in, B. N. Gig. Sanit., No. 2, 95-7 (Feb. 1969). (In Russian).

In a primary sedimentation tank, following a second sedimentation of urban sewage water, 18.6% of the ^{32}P, 17% of the ^{89}Sr, and 51.4% of the ^{144}Ce constituting approximately $^{2}/_{3}$ of the quantities that were connected with the solid phase of the sewage liquids were retained. The biological filter with the secondary sedimentation tank extracted from sewage water the biggest quantity (90 to 99%) of radioisotopes during the first extraction. Subsequently, the effect of decontamination is decreased—with unequal rates for different isotopes—up to a constant level. The degree of decontamination depends on the degree of saturation of the biological filter by the corresponding radioisotope becoming less the greater the concentration of radioisotope in the equipment. The biggest concentration of radioisotopes in the biological filters in all of the periods of decontamination was noted in the uppermost layers. The effective rate (to reduce by half) the content of ^{32}P in the biological filters following the usual regime of work was approximately 12 days, for ^{89}Sr–35 days, and for ^{144}Ce–71 days. (tr-auth)

44469 PREPARATION OF RADIOACTIVE-LABELED POLYSTYRENE LATEX MONODISPERSED SUBMICRON AEROSOLS. Bogen, Donald C. (Atomic Energy Commission, New York). Amer. Ind. Hyg. Ass. J.; 31: 349-52(May-Jun 1970).

Submicron monodispersed polystyrene latex aerosols were labeled with ^{131}I by emulsion polymerization. By the use of catalytic reagents and heat, the polymerization process is started, and subsequently the contaminants are removed by dialysis. Gamma counting of an aliquot of the labeled suspension indicated that about 40% of the initial activity remained on the particles. No significant removal of the label was found with heat or reduced pressure. During application of the labeled aerosol to filter penetration and collection studies, gamma-counting values were obtained that compared closely with microscopy values. Also, the labeling of the particles did not significantly increase the particle size. (auth)

44470 ORIGIN OF SPECIFIC OCCUPATIONAL ILLNESSES IN THE URANIUM INDUSTRY. Vesely, Karel; Sada, Jaroslav. 29 p of Bezpecnost a Hygiena Prace. /Svrcina, Ladislav. Prague: Czechoslovak Atomic Energy Commission (1968). (In Czech).

From Proceedings of Symposium for Workers in the Mining Industry, Pribram, Czechoslovakia. See NP-18271.

There is a high incidence of lung cancer in uranium miners who breathe high concentrations of radon and short-lived decay products. Czechoslovakia is equipping the mines and redesigning the ventilation systems to decrease the radon concentration to 3×10^{-11} Ci/liter by the end of 1970. The Czechoslovakian program for determining the frequency of lung cancer, methods of making calculations, the results, methods for decreasing the radioactivity hazard, indications of occupational disease, and means of protecting workers, together with dosimetry data, are presented. (TTT)

44471 PRINCIPLES UNDERLYING HYGIENIC EVALUATION OF SURFACE DEACTIVATION METHODS. Gorodinskii, S. M.; Gol'dshtein, D. S.; Fadeev, P. E. Gig. Sanit.; No. 2, 45-8 (Feb 1970). (In Russian).

Hygienic evaluation of methods employed in surface deactivation should include: assessment of the given method's efficiency in removing radioactive contaminants; appraisal of the radiation situation and of its changes in the course of deactivation work; an inquiry into the influence exerted by the deactivation procedure used on hygienic properties of the surface materials; toxico-hygienic assessment of the substances, solutions, and equipment employed; appreciation of the microclimate prevalent at the time of deactivation work, and also means available for the removal of the developing radioactive waste. The above listed elements in the hygienic evaluation of surface deactivation procedures are discussed in detail. (auth)

44472 STUDY OF RADIOACTIVE FALLOUT REMOVAL FROM GREEN FODDERS AND OF EFFECT OF FEED SUPPLEMENTS ON MILK CONTAMINATION. Kaufmann, W.; Kraemer, R.; Merten, D.; Rohr, K. (Bundesanstalt fuer Milchforschung, Kiel). Milchwissenschaft; 23: 500-4(1968). (In German).

Values for ^{90}Sr and Ca contents are given for various green fodders in 1964 to 1966. Sugar-beet tops were ensiled with and without AIV solution. Effluent from the former contained 3 times more ^{90}Sr, but difference between the two silages in ^{90}Sr content in DM was negligible. Use of water to wash wilted grass silage in the silo was ineffective. 33.5 mm rain during 4 wk removed 20% of ^{90}Sr from standing clover. In 1964 mean value with SD for ^{90}Sr content of milk of five cows given a normal ration was 17 ± 4.4 pCi/gCa, vs. 15 ± 3.4 for five cows given in addition 160 g Ca daily as $CaCO_3$. Corresponding values (with numbers of tests in parentheses) for groups of cows given: a normal ration; a high ^{90}Sr ration (from moss from Finland); a high ^{90}Sr ration plus 160 g Ca; and a high ^{90}Sr ration plus 300 g alginate were 13 ± 3.1 (20), 90 ± 16.5 (20), 77 ± 9.2 (10), and 65 ± 9.4 (9), respectively. (F.F.M.)

Dosimetry and Monitoring

Refer also to abstracts 44125, 44130, 44234, 44238, 44243, 44245, 44247, 44250, 44251, 44253, 44268, 44325, 44327, 44328, 44331–44333, 44344, 44357, 44403, 44416, 44538, 44568, 44569, 44571, 44578, 44580, 44621, 44623, 45624, 45628, 45630–45632, 45641–45644, and 45647.

44473 (AERE-PR/HPM-14) HEALTH PHYSICS AND MEDICAL DIVISION PROGRESS REPORT, JANUARY–DECEMBER 1969. Johnston, J. E. (ed.) (Atomic Energy Research Establishment, Harwell (England)). Jun 1970. 42p. Dep. CFSTI (U. S. Sales Only). UK 7s. 0d.

Studies are reported under the following headings: aerosol research; aerosols and man; human metabolic studies; whole-body counting; trabecular bone; operational techniques in radiation protection; atmospheric pollution; occupational hygiene; radiation physics; neutron dosimetry and radiobiophysics; personnel dosimetry service; special investigations: radiation spectrometry and computer processing; fallout; cellular radiobiology; medical services; biological applications of radiation processing; soil radioecology, and publication by staff (UK)

44474 (CONF-691101–, pp 146-58) CALCULATION OF DOSE FROM HIGH ENERGY NUCLEONS. Turner, J. E.; Wright, H. A. (Oak Ridge National Lab., Tenn.).

The physical basis for calculations of dose from neutrons and protons with energies up to several GeV is described and the results of several studies are presented in the form of depth dose curves in tissue. The consistency of various dose calculations is discussed, and comparisons are made with experimental measurements. A brief appraisal of the "state of the art" today in calculating dose from high energy nucleons is given. (26 references) (auth)

44475 (CONF-691101–, pp 185-208) MEASUREMENT OF RADIAL AND LONGITUDINAL DOSE DISTRIBUTION IN A WATER PHANTOM IRRADIATED WITH A 10 GeV ELECTRON BEAM. Svensson, G. K.; Nelson, W. R. (Stanford Linear Accelerator Center, Calif.).

The radial and longitudinal distribution of absorbed dose in a water phantom irradiated with 10 GeV electrons had been measured. The electron beam was well focussed, and the current was measured accurately with a toroid. Detector plates containing arrays of thermoluminescent ^{7}LiF dosimeters were inserted at different depths in the water tank. The profiles of the dose distribution were measured over six decades. The dose rate at different depths per unit incoming particle flux density is presented and compared with two different Monte Carlo calculations by Alsmiller and Beck. The variation of the integral dose with electron energy is shown, and its possible significance discussed. The whole body dose versus peak dose for the delta-function type beam used in this experiment is shown. (auth)

44476 (EUR-4452) PROCEEDINGS OF SECOND SYMPOSIUM ON MICRODOSIMETRY, STRESA, ITALY, OCTOBER 20-24, 1969. Ebert, H. G. (ed.) (European Atomic Energy Community). Jan 1970. 867p. (In several languages). (CONF-691038). EUR $16.00.

Separate abstracts were prepared for 40 of the 42 papers presented. The remaining 2 papers were previously included in NSA. (W.H.K.)

For abstracts of individual papers see: 44028, 44245–44254, 44331–44333, 44415, 44416, 44477–44487, 44582, 44590, 44621, 44633, 44634, 44966–44971, 45014, and 45015.

44477 (EUR–4452, pp 107-35) ANALYSIS OF PATTERNS OF ENERGY DEPOSITION. A SURVEY OF THEORETICAL RELATIONS IN MICRODOSIMETRY. Kellerer, Albrecht M. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie. Columbia Univ., New York. Radiological Research Lab.).

The microscopic patterns of energy deposition by ionizing radiation are described by Rossi's probability distributions of specific energy, z. Theoretical derivation and analysis of the microdosimetric functions is based on the concepts of probability theory. These concepts are outlined, some theoretical relations of practical import are listed, and existing computational techniques are referred to. (30 references) (auth)

44478 (EUR–4452, pp 183-92) DISTRIBUTION OF ENERGY DEPOSITED BY NEUTRONS IN THE INTERIOR OF ELLIPSOIDS OF REVOLUTION. Allisy, A.; Boutillon, M. (Bureau International des Poids et Mesures, Sevres (France)). (In French).

Some simple geometrical properties are used to extend to ellipsoidal volumes a previous theory for the calculation of the distribution of the energy deposited by neutrons in spherical volumes. The geometrical properties of the ellipsoid are discussed, and a numerical result is given for 0.5-MeV neutrons penetrating a material equivalent to tissue. (J.F.P.)

44479 (EUR–4452, pp 198-218) VARIATION OF RBE VALUES AND OER FOR COMPLEX HEAVY PARTICLE SPECTRA. Fowler, J. F. (Hammersmith Hospital, London (England). Postgraduate Medical School).

The prediction of Relative Biological Efficiency (RBE) and Oxygen Enhancement Ratio (OER) for beams of densely ionizing radiation would be useful for protection purposes and for machine design in radiotherapy respectively. Extrapolation of these factors from limited measured values in certain biological specimens was attempted by Bewley and by Curtis, with moderate success. Some experiments, however, still give unexpected results. Nevertheless, semi-quantitative explanations can be offered for the relative constancy of OER with neutron energy (except the high value at 0.42 MeV) and for the discrepancy between Barendsen and Todd's results of survival of human kidney cells in track-segment experiments with particles of high LET. Bewley's and Curtis's approach was through LET spectra, which are difficult to determine. The more direct approach through Y spectra will be discussed. An example of an apparent discrepancy between biological results and expectations based on physical measurements has occurred in the finding by Berry, Brennan, et al., that the OER for fast neutrons changes significantly with depth in a tissue-equivalent phantom. Here the Y spectra appear to be more reliable than conventional physical methods. (auth)

44480 (EUR–4452, pp 303-26) EXPERIMENTAL LIMITATIONS OF MICRODOSIMETRY. Rossi, Harald H. (Columbia Univ., New York).

An examination of the objectives of microdosimetry indicates no fundamental experimental limitations except for a lower limit of the measurable energy deposition at the level of single gas ionization. It is shown that when considering energy deposition in an irradiated medium one must accept some lower limit of the energy transferred if the concept is to be useful. The magnitude of this limit is not clearly established but there is some indication that the mean energy expended in a single ionization in a tissue–equivalent gas mixture may be a suitable limit for radiobiological research. (auth)

44481 (EUR–4452, pp 375-400) ASSESSMENT OF DOSE EQUIVALENT FROM FLUCTUATIONS OF ENERGY DEPOSITION. Bengtsson, L. Gunnar (Columbia Univ., New York. Radiological Research Lab.).

Fluctuations in number and size of individual energy deposition events cause fluctuations in the total energy deposited in a small body repeatedly subjected to a constant radiation field during a fixed time. The variance V of the total energy deposition is proportional to the dose average of the energy deposited in single events. V is also approximately proportional to the dose average quality factor, and thus measurement of V can give information on the dose equivalent. An instrument designed for the measurement of dose equivalent through measurement of V was built, using a tissue-equivalent gas proportional counter as the detector, and some preliminary tests are reported. These tests together with theoretical calculations suggest that the instrument could be used to measure the dose equivalent of neutrons in mixed fields to an accuracy of ±20%. The behaviour of the instrument at low neutron energies and in changing radiation fields is discussed. (auth)

44482 (EUR–4452, pp 455-78) APPLICATION OF GENERAL CAVITY IONIZATION THEORY TO THE DOSIMETRY OF ELECTRON FIELDS. Burlin, T. E.; Snelling, R. J. (Polytechnic, London (England)); Owen, B. (National Physical Lab., Teddington (England)).

General cavity ionization theory has proved widely successful in the dosimetry of photon fields. This may be due to the cancellation of errors in the treatment of the attenuation of the two electron spectra (one associated with the surrounding medium and the other with the cavity). For electron fields the attenuation of only one electron spectrum has to be considered and thus their dosimetry imposes a more stringent test on general cavity theory. An experimental examination of cavity theory has been made with β-ray sources irradiating an ionization chamber and also with electron beams from a linear accelerator irradiating a solid state dosimeter. In any situation where the electron spectrum is in a quasi-diffusion condition, the exponential treatment of the attenuation, previously used in general cavity theory, is valid. (auth)

44483 (EUR–4452, pp 685-714) TRACK STRUCTURE IN RELATION TO TARGET STRUCTURE. Burch, P. R. J. (Leeds Univ. (England)).

For certain classes of radiobiological change, RBE stays independent of LET at low LET but declines at high LET. Accurate data for systems of this kind agree with the hypothesis that biological change results from a single random transfer of energy from the ionizing particle to a target zone. For some other types of damage – notably the induction of chromosome aberrations and the inactivation of the proliferative capacity of mammalian cells – RBE first increases with total LET to reach a maximum at around 100 keV/mm and then falls off at still higher LET. This relation was interpreted in terms of a multi-transfer mechanism. Previously, it was supposed that at least n ion pairs have to be formed within a track segment t, and that the distribution of energy transfers within t is random. It will be argued that this model is unrealistic and that attention needs to be given to the structure of the target. When this is done, a consistent interpretation can be given of a wide range of experimental data, the thermoluminescent yield from LiF exhibits LET-dependence. Hence, the possibility exists that solid state dosimeters could be tailored to simulate the LET-dependence of some biological systems. (auth)

44484 (EUR–4452, pp 737-60) INTERPRETATION OF RADIOBIOLOGICAL EFFECTS WITH MICRODOSIMETRY. Booz, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The relation of survival curves and RBE values to the spectral distribution of local energy density is described. Biological threshold and biological variance as well as recovery are taken into account. Using the inhibition of clone formation of human kidney cells as an example the extrapolation of RBE values to very low doses and analysis of the problem of the smallest target size that can be deduced from the measured RBE curves are discussed. (auth)

44485 (EUR–4452, pp 787-800) MICRODOSIMETRY OF ^{125}I WITH REFERENCE TO THE AUGER EFFECT. Ertl, H. H.; Feinendegen, L. E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Medizin).

Nuclides decaying by K-capture and/or internal conversion rearrange inner shell vacancies by the Auger effect, resulting in multi-charged ionization of the atom and charge conversion in the molecule to which the atom is bound. The multi-charged ion may then undergo an explosive disruption by Coulombic forces (Carlson & White, Chemical Effects of Nuclear Transformations, IAEA, Vienna, 23 (1965)). Iodine-125 elicits the Auger effect. It is widely used as a tracer of proteins and DNA (5-iodo-deoxyuridine). Comparing the radiation dosimetry for the case of tritium decay with that of ^{125}I decay (considering the Auger electron emission), radiation effects from the latter are expected to exceed those from the tritium β by a factor of approximately 3. First experimental data, however, indicate that ^{125}I incorporated into DNA of mouse cells in vivo causes additional damage. Since effects from recoil and chemical transmutation are improbable causes for the additional damage observed, secondary effects due to fragmentation of multi-charged molecular ions in consequence of the Auger effect need to be invoked for interpretation. (auth)

44486 (EUR–4452, pp 813-28) DEPTH DEPENDENCE OF LET SPECTRA FOR FAST NEUTRONS IN HUMAN TRUNK

PHANTOM. Krueger, H.; Graul, E. H. (Marburg Univ. (West Germany). Institut fuer Strahlenbiologie und Medizinische Isotopenanwendung). (In German).

The LET spectra at various points in a human trunk phantom filled with tissue-equivalent solution were measured with a tissue-equivalent spherical proportional counter of 1 cm inside diameter. The primary neutron energies were 15 and 3 MeV respectively. The changes in LET with increasing depth within the phantom are given for these neutron energies and discussed, together with the depth/dose curves stemming from these measurements and the depth-dependent changes in the quality factor. (auth)

44487 (EUR-4452, pp 843-53) SUMMARY OF QUANTITIES AND FUNCTIONS EMPLOYED IN MICRODOSIMETRY. Kellerer, A. M.; Rossi, H. H. (Columbia Univ., New York. Radiological Research Lab.).

A summary of the quantities and units employed in microdosimetry and of various probability distributions, averages, etc., which are of direct interest either in the analysis of radiobiological data or in the derivation of one distribution, average, etc., from another, is presented. This is a further development of an earlier summary given by Rossi (1967). (auth)

44488 (INR-1117) RADIOACTIVE CONTAMINATIONS OF THE AREA AND THE ENVIRONMENT OF THE INSTITUTE OF NUCLEAR RESEARCH ZERAN CENTRE IN 1968 YEAR. Gorberg, Zofia; Jaskulski, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1970. 17p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Radioactivity monitoring results from the environs of the Institute of Nuclear Research-Zeran Center during 1968 are given. The radioactivity of fallout, soil, grass, corn, surface waters, and liquid wastes were monitored. The results were compared with the results obtained during 1967. (E.R.B.)

44489 (UCB-34-P-147-X-3, pp 5-9) ^{90}Sr-^{90}Y BETA DOSAGE-DEPTH RELATIONSHIPS IN POLYETHYLENE ABSORBERS. Handley, R.; Grossenbacher, K. A. (California Univ., Berkeley. Dept. of Soils and Plant Nutrition).

An experiment was designed to demonstrate that the dosage maximum for a collimated beam of β particles in a target occurs beneath the surface and to determine the maximum energy peaks for a collimated beam of ^{90}Sr-^{90}Y β particles. The dosage determinations were made by measurement of the attenuation produced by polyethylene shields of varying thickness. Maximum dosage peaks occurred at 0.011 to 0.059 gm/cm^2 (^{90}Sr) and to a lesser extent at 0.154 to 0.210 gm/cm^2 (^{90}Y). (E.R.B.)

44490 EFFECTS OF VARIATIONS IN INPUT DATA ON DOSE DISTRIBUTION DETERMINED BY COMPUTERS. Schoknecht, G. (Staedt. Auguste-Viktoria Krankenhauses, Berlin). Strahlentherapie; 139: 435-45(Apr 1970). (In German).

When judging a calculation method for moving beam dose distribution, it is necessary to know the effect on the obtained results of any variation of the parameters input data. It is then possible to study various problems occurring when the electronic dose distribution calculation is applied in routine radiotherapy. The effects of the patients contour, the pendular angle and axis, and the diagonal dispersion are studied. The influence on the location and form of the 80 and 50% isodoses is also examined. (auth)

44491 SYSTEMATIC PHANTOM INVESTIGATIONS WITH LITHIUM FLUORIDE THERMOLUMINESCENCE DETECTORS ON GONAD BURDEN DURING THERAPY WITH CONVENTIONAL X-RAYS, GAMMA RAYS, BREMSSTRAHLUNG, AND ELECTRON BEAMS FROM 20 TO 43 MeV MAXIMAL ENERGY. Rassow, J.; Struster, H.-D. (Ruhr Univ., Essen). Strahlentherapie; 139: 446-58(Apr 1970). (In German).

The gonadal dose in radiotherapy was measured during irradiations with photons or electrons from 0.06 to 43 MeV. The measurements were made in standardized conditions and with a maximum error of 3%. The thermoluminescent dosimeters measured $1.4 \times 1.4 \times 7$ mm^3 in volume. They were almost independent of energy and could detect a dose difference of 2.4 mrad. They were placed in an Alderson phantom at the ovarian or testicular location. With thoracal and abdominal irradiation with stationary fields, relative gonadal doses of 0.3 to 6‰ were observed, and of 0.07 to 7‰ of the maximal dose. A table of factors was compiled that allowed a rapid calculation of the gonadal dose. (auth)

44492 RADIATION EMISSION FROM A TELEVISION PROJECTION SYSTEM. Matthews, James D. (Ohio Univ., Athens). Health Phys.; 18: 541-5(May 1970).

High exposure rates were observed in the vicinity of a television projection system. Exposure rates as high as 500 mR/hr, one foot from the cathode-ray tube, were determined. Inadequate shielding around the optical housing section seems to be the primary cause of excess exposure rate reading in the environ of the television projection unit. If the NCRP and the ICRP recommendations, regarding maximum exposure rates from home television receivers, are applied to television projection units, the exposure rates would certainly be exceeded. (auth) (UK)

44493 RADIATION DOSE IN ISOTOPE ENCEPHALOGRAPHY. Harbert, J. C. (Georgetown Univ. Hospital, Washington, D. C.). Lancet; 1: 954-5(2 May 1970).

Measurements were made of isotope concentrations in segmental compartments of the spinal subarachnoid space. Patients with normal C.S.F. dynamics, hydrocephalus, and complete spinal block, received 100 μCi ^{131}I-human-serum-albumin (H.S.A.) by lumbar intrathecal injection. Using a modified scintillation camera, the isotope distributions over three 5-inch segments of the spinal subarachnoid space were quantitated at several intervals over 48 to 72 hours, and the cumulated activity determined. The C.S.F. volumes for the lumbar and thoracic spaces were estimated from contrast myelographic studies. Mean values of cumulated activity for normal, hydrocephalic, and patients with complete spinal block were 400, 700, and 3000 μCi-hr respectively. The calculated β dose, which was the major contribution to the total absorbed dose, decreased one hundred fold over 1 mm distance from the cord surface. Nerve-roots of 0.1 cm diameter received about 20% higher surface dose than a spinal cord segment of 0.95 cm diameter, the dose falling off less rapidly from the surface than in the cord. Using a range of 10 to 35 ml per 5 inch segment, the range of total surface absorbed doses from a 100 μCi lumbar intrathecal injection for normal C.S.F., hydrocephalous, and spinal block patients was 3 to 7 Rads, 7 to 12 Rads, and 5 to 60 Rads. (UK)

44494 THE RADIATION DOSIMETRY OF A SHORT-LIVED RADIOPHARMACEUTICAL ACIDIC ^{113m}In. Towson, Jocelyn (Royal Prince Alfred Hospital, Camperdown, Australia). Australas. Radiol.; 14: 94-100(Feb 1970).

Acidic ^{113m}In (pH < 1.8) has the necessary short life for low-dose pediatric and obstetric investigations, in particular placental localization. It gives 100% whole-body retention, negligible renal excretion, greater than 80% activity bound to circulating transferrin, the remainder of the dose accumulated in the reticuloendothelial system, and no transfer across placenta. Radiation doses for 1.0 mCi of ^{131m}In for whole-body and various organs are compared with dosages for other radionuclides. (auth) (Australia)

44495 EXPONENTIAL DECREASE OF ^{137}Cs IN MAN FROM MID-1965 THROUGH MID-1968 AND ITS SIGNIFICANCE. Joyet, G.; Joyet, M.-L. (Univ. of Zurich). Health Phys.; 18: 455-65 (May 1970).

The measurement of whole-body ^{137}Cs in different groups of men from spring 1966 through mid-1968 in Zurich and East-Switzerland shows an exponential decrease with an effective half-life of 15 ± 1 months. Similar figures were found in London, Chicago, and Los Alamos and the significance of this half-life was studied. It is shown that an exponential decrease is apparent and results from the two sources of ^{137}Cs in the food-chain, namely, the direct stratospheric fallout with a shorter half-life and, on the other hand, the nearly constant activity of the superficial layer of fertile loam. (auth) (UK)

44496 SYSTEM FOR CONTINUOUS MONITORING OF POTENTIAL DOSE RATE TO THE GASTROINTESTINAL TRACT FROM DRINKING WATER. Bramson, P. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 18: 523-7(May 1970).

A system for continuous monitoring of the potential gastrointestinal (GI) tract dose rate of a drinking water supply was developed and proven at Hanford. The system consists of a cylindrical plastic well crystal coupled to a 3-in. photomultiplier. A water sample flow is circulated through the well at a rate of 1 l/min. The count rate after amplification and discrimination is proportional, within a factor of two, to GI tract dose rate for at least nineteen radionuclides including seven radionuclides that contribute 90% of the potential GI tract dose rate from consumption of drinking water derived from Columbia River water near Hanford. Detection limit at 95% confidence is 1 ± 1 mRem/month. Contamination buildup is controlled by continuous injection of a sodium salt of ethylenediaminetetraacetic acid to a measured flow. (auth) (UK)

44497 AVERAGE EXPOSURE TO RADIATION WORKERS IN PAKISTAN. Mirza, K. F.; Malik, W. K. (Atomic Energy Centre, Lahore). Health Phys.; 18: 569(May 1970).

For the past 9 yr the Pakistan Atomic Energy Commission has been making its radiation-monitoring facilities available to various radiation users in the country. At present nearly 600 persons are monitored every month. It was found that, on an average, each radiation worker in Pakistan received an exposure of 34.3 mR/week. For every hundred films processed there were almost five films showing exposures greater than 100 mR/week. (auth) (UK)

44498 DOSAGE-DEPTH RELATIONSHIP FOR A COLLIMATED $^{90}Sr-^{90}Y$ BEAM. Grossenbacher, K. A.; Handley, R. (Univ. of California, Berkeley). Health Phys.; 19: 23-6(Jul 1970).

The attenuation of $^{90}Sr-^{90}Y$ β-radiation by polyethylene shields of various thicknesses was measured using a collimated beam from a thin source and a Fricke solution detector. From the data obtained the dosages received at various levels within the absorber were calculated. The results indicate that the highest dosage occurs at or near the proximal surface of the absorber and that a secondary internal dosage maximum occurs at a depth of 0.154 – 0.210 g/cm^2. (auth) (UK)

44499 LINEAR ABSORPTION COEFFICIENTS FOR GAMMA RAYS IN TISSUE. Smith, Harry L.; Neff, Richard D. (Texas A and M Univ., College Station). Health Phys.; 19: 59-60 (Jul 1970).

Tissue absorption coefficients as calculated from constituents given by Morgan and Turner (NSA 22: 10778) are compared with those calculated from the air absorption coefficients for photon energies from 0.04 to 1.0 MeV and the differences discussed. The percentage difference increases with decreasing photon energy and increasing tissue thickness, being 38.25% for photon energy 0.04 MeV and effective radius 30 cm. However, at high photon energies and small effective tissue radii the calculated gamma absorption error is negligible. Due to the absence of tissue absorption coefficients in the literature, these were calculated by proportionate summing from values for tissue constituents found in the literature and are plotted against photon energy from 0.01 to 100 MeV. A correction for Compton interaction was applied to each tissue element. (UK)

44500 RADIATION DOSE TO THE GASTROINTESTINAL TRACT OF SHEEP FED AN INSOLUBLE β-EMITTER. Wade, L.; Hall, R. F.; Sasser, L. B.; Bell, M. C. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Health Phys.; 19: 57-9 (Jul 1970).

Sheep were fed a radioactive fallout simulant composed of silica sand to which ^{90}Y (specific activity 10 mCi/g) was fused, and the radiation dose to the gastrointestinal tract measured. A total activity of 7.2 mCi/kg body wt, divided into equal portions, was fed to each animal over a three-day period. After a further two days, one sheep was scanned to determine the areas of greatest concentrations of radioactivity and the results compared with x-ray scanning following a barium meal. Three areas of concentrated activity were detected, the ventral sac of the rumen, the abomasum and omasum, and the caudodorsal blind sac of the rumen. The radiation dose to several points of the gastrointestinal tract of 14 sheep was measured by silver-activated metaphosphate glass rods enclosed in threaded nylon capsules. A table of results is given and analyzed. The difficulties of measurement are discussed. (UK)

44501 EXPOSURE RATES FROM DIAGNOSTIC X-RAY UNITS. McCullough, E. C.; Cameron, J. R. (Univ. of Wisconsin, Madison). Brit. J. Radiol.; 43: 448-51(Jul 1970).

X-ray exposures were computed at a focus-to-skin distance of 40 in. for a wide range of mAs, kVp and filtrations to cover most diagnostic x-ray procedures. The computations, based upon Kramer's rule for differential bremsstrahlung spectra, are in good agreement with experimental values obtained under a variety of operating conditions. (auth) (UK)

44502 IN-VIVO AND BIOASSAY RESULTS FROM TWO CONTRASTING CASES OF ^{239}Pu INHALATION. Ramsden, D.; Bains, M. E. D.; Fraser, D. C. (Atomic Energy Establishment, Winfrith, Eng.). Health Phys.; 19: 9-17(Jul 1970).

In vivo and bioassay measurements following two incidents involving ^{239}Pu inhalation are described and contrasted. Incident 1, involving the inhalation of insoluble plutonium oxide, resulted in a lung content of about 20 nCi after the initial clearance. Urine excretion was negligible and the estimation of exposure was based on "in vivo" data and faecal excretion. Incident 2, involving the inhalation of soluble plutonium, proved negligible and the estimation of exposure, based on urinary excretion, was 0.6 nCi. (auth) (UK)

44503 SPECIFICATION OF THORIUM-X ACTIVITY: THE E. S. U. TO CURIE CONVERSION. Schales, F. ; Jones, D. E. A. Brit. J. Radiol.; 43: 471-8(Jul 1970).

Thorium-X (^{224}Ra) preparations for therapuetic use have until recently been assayed in "e.s.u." terms, but a conversion to a curie specification has now been made both by the British and German producers. The former unit, the e.s.u. ThX, is shown to be largely based on a very early experimental technique for the measurement of α-ray ionisation, such that the geometry of the apparatus and the rapidity with which the measurement followed the separation of the ThX sample from its parent, severely limited the α particles that could participate in the ionisation. The equivalent of 1,000 e.s.u. ThX derived by this method is 173 μCi and 143 μCi of ^{224}Ra respectively depending on the country of origin, Germany and Great Britain, respectively. Theoretical calculations made in the past have often neglected these experimental limitations, and thus provide equivalence values of about 70 μCi of ^{224}Ra. Although the "e.s.u. ThX" would appear to have some merit in dermatological use, because it takes into account the appreciable emission of "delayed" α particles from ThC (^{212}Bi), its use in the case of internal administration is shown to have serious disadvantages. It is recommended that for both superficial and internal applications activities should be expressed in curie terms at the proposed time of use. Injection ampoules should also be accompanied by a statement of the times both of separation from the parent ^{228}Th solution and of the proposed administration. The information in this paper may provide some assistance in the investigation of tissue dose where damage to patients has followed certain cases of ThX injection in the past. (auth) (UK)

44504 STATE PROGRAM FOR REDUCING RADIATION EXPOSURE FROM DENTAL X-RAY MACHINES. Travis, K. L.; Hickey, J. E. (Rhode Island Dept. of Health, Providence). Amer. J. Public Health; 60: 1522-7(Aug 1970).

A program for reducing the primary exposure during dental x-ray examinations is presented. Data are included to indicate the accomplishments of the program. The study finds that, although a large reduction in radiation exposure has been realized since 1960, dentists still use, on the average, two to three times the necessary radiation per exposure. Among the reasons for this situation, the most important seem to be the inadequacy of mechanical timers and the highly prevalent use of the sight development technique. Both of these problems account, to a great extent, for the continuing use of slower speed film by a large percentage of dentists. The program, if adopted by other states, could have a significant impact on reducing radiation exposure to the population. It is the opinion of the authors that the program is potentially a successful and realistic method of substantially reducing exposure to the population. Unlike previous studies, which concentrated on documenting exposure, this program provides the means of correcting high exposures on the spot while performing a needed and tangible service to the dentist. (auth)

44505 ABSORBED DOSE FROM RADIONUCLIDES. Hine, Gerald J. (Veterans Administration Central Office, Washington, D. C.); Johnston, R. Eugene. J. Nucl. Med.; 11: 468-9(Jul 1970).

The absorbed radiation dose to various organs of the human body from radioisotopes used in nuclear medicine was tabulated. The table is based on data available in the literature as of March 1970, and is intended only as a guide to the estimated ranges reported for the administration of a radiopharmaceutical. (E.R.B.)

44506 INTERNAL DISTRIBUTION AND ABSORBED DOSE CALCULATIONS FOR RADIOACTIVE INDIUM LIVER AND LUNG SCANNING AGENTS. Brookeman, Valerie A.; Sun, Paul C. J.; Bruno, Fred P.; Dunavant, Billy G.; Mauderli, Walter (Univ. of Florida, Gainesville. Veterans Administration Hospital, Gainesville, Fla.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 735-41(Aug 1970).

Data are presented on the tissue distribution of ^{113m}In colloids and ^{113m}In-iron hydroxide aggregates in rats. The data were used to estimate the internal absorbed dose (rads) to human organs during liver and lung scanning using these agents. (C.H.)

44507 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 11: 333-41(Jul 1970).

The average ^{90}Sr, ^{137}Cs, and ^{131}I content of milk in the United States during March 1970, and the averages for the 12-month period ending in March 1970 are given. Samples were collected by the State Sampling Network and the Pasteurized Milk Network. All data are presented in tabular form. No data are presented from the various food and diet surveillance programs. (E.R.B.)

44508 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 11: 345-8(Jul 1970).

The ^{90}Sr content and the $^{137}Cs/^{90}Sr$ ratio in New York City tap water are given for January to December 1969. The monthly

averages of ^{90}Sr in tap water samples are presented in graphic form for 1955 through 1969. The tritium content of samples collected by the Surface Water Network is given for July to December 1969. Because of the current level of interest in tritium, the network sampling stations are being expanded in the areas of operating and planned nuclear facilities. (E.R.B.)

44509 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 11: 357-65(Jul 1970).

As a part of the continuing surveillance of environmental levels of radioactivity at AEC installations, the following data were collected at Argonne National Laboratory during January to June 1969. The α, β, and γ radioactivity in air-filter samples; the ^{41}Ar content of surface air near Juggernaut reactor and the tritium content of surface air near CP-5 reactor; the non-volatile α and β radioactivity and the content of α- and β-emitting radioisotopes in Sawmill Creek Water; the average radioactivity in Des Plaines and Illinois River water and the content of α-, β-, and γ-emitting radioisotopes in Des Plaines River water; and the ^{137}Cs and ^{90}Sr content of milk from the Argonne vicinity. The onsite and offsite environmental monitoring facilities at the SIC Prototype Reactor Facility are discussed including air monitoring, liquid radioactive waste monitoring, water monitoring, and airborne radioactivity monitoring. Some results are given for 1968. The USAEC announced one underground nuclear test at the Nevada Test Site during June 1970 and recorded seismic signals from the Soviet nuclear test area on June 27, 1970 indicating a low to intermediate yield test. (E.R.B.)

44510 ACCURATE WHOLE-BODY QUANTITATION OF ^{131}I RETENTION BY COUNTING A SCATTER WINDOW. Gibbs, William D.; Hodges, Harold D.; Bailey, Mildred; Lushbaugh, C. C. (Oak Ridge Associated Universities, Tenn.). J. Nucl. Med.; 11: 487-90(Aug 1970).

Accurate relative or absolute quantitation of human ^{131}I content cannot be achieved by the spectral photopeak counting methods now used in whole-body counting because the radioisotope undergoes extreme changes in distribution with time, resulting in a variable detection efficiency. Studies by Haim and Dudley and Miller show that total Compton counts are less variable than photopeak counts although the total Compton counts also vary considerably when changes occur in radioisotope distribution within the body. The studies of Dudley and Miller suggest that a minimum error window may exist if the counts in some energy band of the ^{131}I spectrum are less affected by changes in bodily distribution than either those in the photopeak or the entire Compton spectrum. We have tested this hypothesis experimentally and then used the optimal scatter window we obtained for ^{131}I in clinical studies. (auth)

44511 MEASUREMENT OF THE L.E.T. DISTRIBUTION WITHIN A REACTOR ENVIRONMENT. Lucas, A. C. (EG and G, Inc., Santa Barbara, Calif.); Simpson, R. E. Health Phys.; 18: 580-1(May 1970).

In support of mixed field dosimetry measurements around a reactor, L.E.T. spectra were accumulated at four separate locations using a 2-in spherical proportional counter and a 200 channel pulse height analyzer. The results are given and discussed. (UK)

44512 EXTENSION OF THE CONCEPT OF TISSUE-AIR RATIOS (TAR) TO HIGH-ENERGY X-RAY BEAMS. Holt, J. Garret; Laughlin, John S.; Moroney, John P. (Memorial Hosptial for Cancer and Allied Diseases, New York). Radiology; 96: 437-46(Aug 1970).

A new function, the tumor-maximum ratio (TMR), is defined for high-energy x-ray beams, permitting the concept of isocentric dose calculations to be extended into the high-energy x-ray region. The central axis dose in the medium is computed from a derived function, the attenuation factor α. The method of dose computations using α is illustrated, and TMR and α tables for 6 MeV x rays are provided. With an increasing number of isocentric high-energy x-ray generators being employed in clinical dosimetry, the application of α should be helpful in the necessary calculations. (auth)

44513 IN VIVO DOSIMETRY WITH EXTRUDED LITHIUM FLUORIDE RODS. Bloch, Peter (Univ. of Pennsylvania, Philadelphia). Radiology; 96: 425-7(Aug 1970).

In external radiation-beam therapy it is difficult to calculate the dose to a point when the treatment beam passes through air-containing tissue. Of two approaches used to correct for the effects of tissue heterogeneity, one determines the water-equivalent thickness that the x-ray beam passes through; the other measures the dose to particular points in a patient directly. The dose delivered to the esophagus during radiation therapy of the upper chest was measured by inserting a catheter containing LiF rods into the esophagus, and the measured dose agreed with the dose calculated using the determined water-equivalent thickness of the patient. (auth)

44514 ENVIRONMENTAL SURVEILLANCE AROUND NUCLEAR POWER REACTORS. Lieberman, Joseph A.; Harward, Ernest D.; Weaver, Charles L. (Environmental Health Service, Rockville, Md.). Radiol. Health Data Rep.; 11: 325-32(Jul 1970).

An analysis of data from nuclear plants currently operating in the United States has shown that discharges of radioactive wastes have generally been small percentages of AEC regulatory limits and have resulted in minimal or undetectable radiation exposure to the population. Studies carried out to date by the Bureau of Radiological Health have confirmed this to be the case. If good waste management practices are carefully followed by reactor plant operators, the resulting radiation exposures to the public should continue to be extremely low. However, the existence of multiple reactor sites and areas containing several sites will require that monitoring programs be designed to consider the possibility of radiation effects from a large number of nuclear power sources. Because of the large number of nuclear plants which will ultimately require surveillance programs, efforts are being made by the Bureau to reevaluate recommendations for environmental surveillance programs for maximum effectiveness. Results of field studies conducted thus far indicate that a surveillance program as previously described will satisfy public health requirements if the effluents are well defined and if the critical radionuclides in the effluents and pathways to the population are clearly identified. The Bureau of Radiological Health will continue to carry out its responsibility for evaluating the environmental levels of radioactivity through a nationwide surveillance program, technical assistance to States, research and development activities, and the analysis of environmental radiation data from all sources. This function is currently being strengthened to ensure an adequate evaluation of the impact of the growing nuclear power industry on radiation levels in the environment and the continued protection of the public health. (auth)

Radiation Protection

44515 (CONF-691101–, pp 21-30) RECENT WORK OF THE NCRP, ICRU AND ICRP OF INTEREST TO ACCELERATOR HEALTH PHYSICISTS. Cowan, Frederick P. (Brookhaven National Lab., Upton, N. Y.).

The organizations and recent publications on accelerator health physics of the National Council on Radiation Protection and Measurements (NCRP), International Commission on Radiation Units and Measurements (ICRU), and the International Commission on Radiological Protection (ICRP) are briefly discussed. (W.H.K.)

44516 (CONF-691101–, pp 31-41) RADIOLOGICAL SAFETY IN THE DESIGN AND OPERATION OF PARTICLE ACCELERATORS. Vallario, Edward J. (Atomic Energy Commission, Washington, D. C.); Howe, Harry J. (Argonne National Lab., Ill.).

The United States of America Standards Institute (USASI) Main Committee N-43, "Equipment for Non-Medical Radiation Application," examined the need for establishing radiation-protection norms for particle accelerators. A subcommittee designated as N-43.4 Particle Accelerators was established to develop a National Standard on Radiological Safety in the Design and Operation of Particle Accelerators. In undertaking this assignment, the subcommittee realized that for the purpose of the standard it was necessary to define particle accelerators in terms of energy. Differences in design considerations as well as uncertainties in radiation measurement for the high energy accelerators suggested that this standard be limited to particle accelerators having primary energies less than 100 MeV. The basic considerations included the characteristics of and controls for radiation as they affect accelerator design, operating procedures, and exposure evaluation. The radiation protection design criteria included guidance on radiation shielding, radiation damage, i.e., deterioration of insulating materials and related methods for minimizing damage; safety systems, i.e., methods by which desired protection can be achieved; and design considerations for accelerator controls, interlocks, and warning devices. Sections on Operational Health Physics, Radiation Measurements and Dose Assessment provide procedural guidance basic to radiation safety. The proposed standard has received full approval from the Main Committee and is awaiting official sanction by the USASI Nuclear Standards Boards before becoming a United States Standard. (auth)

44517 EYE PROTECTION IN ^{60}Co TELETHERAPY BEAMS. Jones, C. H. (Royal Marsden Hospital, London). Brit. J. Radiol.; 43: 73-4(Jan 1970).

The variation of percentage depth dose in Perspex from 0 to 2.5

g/cm^2 was examined beneath lead shields (1.5 cm × 7 cm) in ^{60}Co beams. Protection could be achieved by placing a 4 mm thick Perspex disc over the eye, or if the patient were treated in a fixation cast, by increasing the cast thickness over the appropriate area. (UK)

Safety Procedures

Refer also to abstracts 45639 and 45648.

44518 (NP–18286) RADIATION HEALTH AND SAFETY. Annual Report for the Year Ended 31st December 1968. (New South Wales Univ., Kensington (Australia)). 1969. 18p. Dep. CFSTI (U. S. Sales Only).

All aspects of the work concerning the university's radiation protection officer are covered, under such headings as Purchase and Transfer of Radiation Sources, Personnel Monitoring, Publications, Waste Disposal, Radiation Incidents, Insurance, and Research. An appendix gives details of radioactive materials and apparatus received and on order. (auth)

44519 RADIOLOGICAL PROTECTION OF WORKERS EXPOSED TO AIRBORNE PLUTONIUM PARTICULATE. Holliday, B.; Dolphin, G. W.; Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys.; 18: 529-40 (May 1970).

The primary purpose of routine environmental monitoring is to check the working environment and confirm that operating conditions are satisfactory. The paper outlines how the results of environmental monitoring can be used to achieve this and also to define a routine individual monitoring program. Current models of the behavior of plutonium in the body are used to provide numerical guidance on the use of monitoring data for adjusting routine programs and initiating special investigations of individual cases. This quantitative use of the data leads to an effective, integrated program of environmental and individual monitoring. (auth) (UK)

44520 OCULAR TRAUMA IN INDUSTRY. Novak, Joseph F. (Univ. of Pittsburgh). J. Occup. Med.; 12: 287-90(Aug 1970).

The industrial sources of ocular trauma are discussed. These include the following: foreign bodies; intraocular foreign bodies; chemical injuries; corneal abrasions; contusion; lacerations; facial and orbital fractures; and radiation injuries. The sources of radiation injury include uv radiation as in welder's flash; infrared, visible, and uv radiation as in radiational thermal burns or flash burns; and laser radiation resulting in corioretinal burns. Plasma torches are also a source of radiation injuries. At least 90% of these ocular traumas could be avoided by wearing industrial safety eye wear in hazardous situations. (E.R.B.)

44521 RADIATION SAFETY: A SURVEY OF NDT TRENDS, PROBLEMS, GUIDELINES. Bellian, Joseph G. (VLN Corp., Cleveland). Mater. Eval.; 28: 23A-6(Jul 1970).

The radiation hazards associated with nondestructive testing (NDT) procedures are reviewed in the light of basic radiation safety criteria. A brief summary of the radiation-producing units used in NDT, the number of companies employing NTD techniques, the location of NDT equipment, and the types of products tested is presented. The probable biological effects of whole-body exposures, expressed in rems, and the difficulty of measuring scatter radiation are discussed. Practical rules are suggested for applying the time-distance-shielding limitations on radiation exposure. The AEC requirements regarding the establishment of supervised areas for use of radiographic or NDT equipment and the instruments required by the AEC for monitoring radioisotopes and radiation sources are presented. The characteristics, approximate cost, type of radiation measured, and recommendations for use of a variety of commercial detectors, monitors, and survey meters are given in tabular form. (E.R.B.)

44522 BEZPECNOST A HYGIENA PRACE. Symposium Pracovniku Banskeho Prumyslu Hornicka Pribram ve Vede A Technice 1968. (Occupational Safety and Health Protection. Proceedings of Symposium for Workers in the Mining Industry, Pribram, Czechoslovakia, 1968). Svrcina, Ladislav. Prague: Czechoslovak Atomic Energy Commission (1968). 163p. (NP–18271).

Seven papers are included in the proceedings of the section on occupational safety and hygiene. Separate abstracts were prepared for three of these. (TTT)

For abstracts of individual papers see: 44470, 44523, and 44524.

44523 ILLNESS IN WORKERS IN THE URANIUM INDUSTRY. Pacina, Vladimir (ZUNZ Uranium Industry, Pribram, Czech.). 30 p of Bezpecnost a Hygiena Prace. /Svrcina, Ladislav. Prague: Czechoslovak Atomic Energy Commission (1968). (In Czech).

From Proceedings of Symposium for Workers in the Mining Industry, Pribram, Czechoslovakia. See NP–18271.

Several physiological and pathological conditions in uranium industry personnel are discussed. In the refining process, personnel may be contaminated with raw materials, intermediate products, or the final products of the process. In the mines, a specific hazard is the breathing of radon and its decay products. Cases of lung cancer in miners are tabulated for 1950 to 67, though a condition thought to be lymphosarcoma was detected as early as 1879. Like all miners, the uranium miner is also subject to vasoneurosis and the accompanying tremors and to damage to his hearing and motor apparatus due to high-frequency vibration. Silicosis is another hazard, and breathing of combustion products may cause headaches, general malaise, nausea, and other common symptoms. (TTT)

44524 REQUIREMENTS FOR SEEING IN UNDERGROUND URANIUM MINES. France, Alex (ZUNZ Uranium Industry, Pribram, Czech.). 6 p of Bezpecnost of Hygiena Prace. /Svrcina, Ladislav. Prague; Czechoslovak Atomic Energy Commission (1968). (In Czech).

From Proceedings of Symposium for Workers in the Mining Industry, Pribram, Czechoslovakia. See NP–18271.

The importance of good lighting in underground uranium mines is stressed. Good lighting depends not only on the amount of light incident on the working surface but also on that reflected from the working surface. Averages and ranges of values are given for the reflectivity of some wet and dry rocks most frequently found in uranium mines. Some factors that interfere with good lighting are low intensity of light sources, small amount of light falling on the working surface, insufficient contrast between working surface and background, and presence of a film or haze, which acts directly, decreasing the light further, or indirectly, interfering with the vision of the operator. (TTT)

44525 CARCINOGENIC HAZARDS OF IONIZING RADIATION IN DIAGNOSTIC AND THERAPEUTIC RADIOLOGY. Stein, Justin J. Progr. Clin. Cancer; 4: 231-41(1970).

Patients accept risks in undergoing surgical operations and in taking drugs of various types. No one should hesitate to have diagnostic x-ray examinations or to accept radiotherapy when indicated and properly administered. Every possible effort is being made to improve radiation equipment and technics, as well as the education of physicians and technicians using such equipment, to further reduce the amount of radiation exposure to the population. Although there are carcinogenic hazards that may result from the use of ionizing radiation in diagnostic and therapeutic radiology, when the radiation is used under proper conditions the potential hazards are minimal. (auth)

Civil Defense

44526 (AD–704727) TRANSATTACK ENVIRONMENT SCENARIOS. Final Report. Harker, Robert A. (URS Research Co., Palo Alto, Calif.). Jan 1970. Contract DAHC20-68-C-0128. 61p. CFSTI.

Emergency Operations Attack Scenarios for New Orleans and Detroit are presented. These Scenarios indicate the responses within the cities to environmental changes that would occur during the first six hours after the receipt of attack warning. Also, there is description of the background research for the transattack environment simulation that was presented to New Orleans government officials. An analysis of the applicability of this research work to OCD's Emergency Operations Simulation Training program is also included. (auth) (USGRDR)

Legal Aspects

44527 MPC VALUES FOR ^{102}Rh, ^{102m}Rh, AND ^{107}Pd. Soldat, J. K. (Battelle Memorial Inst., Richland, Wash.). Health Phys.; 19: 60-3(Jul 1970).

MPC values for ^{102}Rh, ^{102m}Rh, and ^{107}Pd were required since these are not listed by the ICRP and these metals are to be recovered from radioactive wastes at Hanford. These were calculated using data from Lederer et al. (NSA 21: 44657). Occupational MPC values for ^{102}Rh, ^{102m}Rh, and Pd are given for the total body, kidneys, spleen, bone, liver, gastrointestinal tract, and lungs. Limiting occupational MPC values are also given. (UK)

Medicine

Refer also to abstract 44617.

44528 EVALUATION OF PERMANENT PARTIAL DISABILITY IN RADIODERMATITIS. Masse, R. Med. Leg. Domm. Corpor.; 1: 68-71(Jan 1968). (In French).

Two cases of radiodermatitis were examined to see what evaluations on the permanent partial disability could be drawn from the etiological, clinical, diagnostics, and prognostic elements. (J.S.R.)

Protective Substances

44529 RADIOSENSITIVITY OF MALIGNANT TUMORS PRETREATED WITH PHOTOSENSITIZING TETRACYCLINES. Dell, M.; Klemm, J.; Lindhorst, K.; Schlegel, D. (Univ., Munich. Medizinische Univ., Munich). Strahlentherapie; 139: 512-15 (Apr 1970). (In German).

Rats with a Yoshida sarcoma were irradiated with doses of 3000 R with or without pre-treatment of DCMT. The dimensions of the tumors were measured afterwards. The average values, the statistical differences within each group were discussed. Pretreatment with DCMT does not seem to influence the radiosensitivity. (auth)

44530 METHOD FOR SINGLE X RADIATION UNDER HYPOTHERMIA. Brunner, J.; Domanig, E.; Fochem, K.; Michalica, W.; Picha, E. (Univ., Vienna). Strahlentherapie; 139: 431-4 (Apr 1970). (In German).

Various radiotherapy methods with superficial hypothermia or extracorporeal cooling are reported and discussed. In spite of one lethal incident, the second method is preferred. (auth)

44531 PROTECTION AGAINST EARLY RADIATION INJURY TO THE MICROVASCULATURE. Stearner, S. Phyllis; Christian, Emily J. B. (Argonne National Lab., Ill.). Microvasc. Res.; 2: 202-11(1970).

Early radiation injury in some species of higher vertebrates includes vascular damage that may result in circulatory stasis and death within a few hours after exposure. The chicken exhibits an early edema and hemoconcentration, and terminal events include widespread stasis and degenerative changes of the endothelium. Described in this report are the effects of protective procedures against early radiation injury to the microcirculation, studied in the extraembryonic membranes of the living, explanted, 3-day chick embryo. Early vascular damage after a lethal radiation exposure was reduced in embryos pretreated with a conditioning x ray exposure, 4 hr before the second, or challenging, dose (a split exposure). A similar protective response was observed in irradiated embryos pretreated with the antiprotease, soybean trypsin inhibitor. These results suggest that resistive processes are active during the interval between exposures and that effects leading to vascular degeneration can be reversed or prevented at an early stage in development of the injury. The possible relation of activated or released hydrolases to the early microvascular damage is discussed. (auth)

44532 DOSE REDUCTION FACTOR PRODUCED BY INTRAPERITONEAL ADMINISTRATION OF PHYTOHEMAGGLUTININ IN MICE. Stefani, S.; LeVan, H. (Veterans Administration Hospital, Hines, Ill.). Health Phys.; 19: 19-21(Jul 1970).

Phytohemagglutinin (PHA) was found to produce a dose reduction factor of about 1.25 and 1.51 respectively when administered intraperitoneally in mice. The animals were exposed to six dose levels of x-irradiation between 550 and 800 R 20 to 80 min before or after receiving 120 mg of PHA. (auth) (UK)

44533 PROTECTION BY CYSTEAMINE AGAINST MITOTIC DELAY AND CHROMOSOMAL ABERRATIONS INDUCED BY X-RAYS IN SYNCHRONIZED CHINESE HAMSTER CELLS. Yu, C. K.; Sinclair, W. K. (Argonne National Lab., Ill.). Radiat. Res.; 43: 357-71(Aug 1970).

The magnitude of mitotic delay and the incidence of chromosomal aberrations depend upon the stage at which irradiation occurs in the cell generation cycle of synchronized Chinese hamster cells in vitro. Because cysteamine has a differential protective effect upon cell lethality during the cell cycle, the dependence of its protective effect against mitotic delay and chromosomal aberrations upon cell cycle position was investigated. The results show that cysteamine-treated cells have a pattern for radiation-induced mitotic delay and chromosomal aberrations similar to that for untreated cells, except that the dose required is much higher. The fact that a differential effect was not observed may be because the degree of synchrony was not sufficient to permit the detection of small differences. However, the magnitude of the dose-modifying factor for cysteamine differed in each assay from those previously reported for lethality. The dose-modifying factor for mitotic delay was about 2.5 throughout the cell cycle, for single-hit aberrations it was about 8, and for two-hit aberrations, about 5. (auth)

44534 RADIUM NECROSES AND ABUSE OF NICOTINE. Picha, E. I. (Univ., Vienna). Wien. Klin. Wochenschr.; 81: 260-1(1968). (In German).

A possible connection is suggested between excessive cigarette smoking and the occurrence of the severe radionecrosis of the vaginal cervix and the vagina, that occasionally appears after genital radiotherapy in women. Vessel changes associated with excessive cigarette smoking can be distinguished as support of this theory. (Excerpta Med.)

44535 STUDIES ON THE RADIOSENSITIZING PROPERTIES OF CERTAIN COMPOUNDS RELATED TO 5,8-DIHYDROXYPSORALEN. Bordin, Franco; Busulini, Loris; Baccichetti, Francarosa; Bevilacqua, Rita (Univ., Padua. CNR, Padua). Ric. Sci.; 39: 626-31(Jul-Sep 1969). (In Italian).

A study was made of the transmissibility of the mouse Ehrlich ascites tumor cells after γ irradiation in vitro in the presence of certain compounds related to 5,8-dihydroxypsoralen, a new radiosensitizing drug. Certain derivatives proved to be completely inactive when either only one or both hydroxyl groups were substituted (the sole exception being 5,5-diacetoxypsoralen). Hydroquinone and 5,8-dihydroxycoumarin also gave entirely negative results. On the contrary, 4,7-diacetoxybenzofuran and methyl ester of 4,5-dihydroxybenzofuran-2-carboxylic acid showed activity in vitro. It would appear, therefore, that the radiosensitizing properties of 5,8-dihydroxypsoralen are related to two phenolic groups while the presence of all the three rings, characteristic of the furocoumarin structure, does not seem essential to the activity of the molecule. (auth)

Radiation Sickness and Injuries

Refer also to abstract 44425.

44536 ACTION OF ELLAGIC ACID ON THE TIME AND INTENSITY OF HEMORRHAGE OF IRRADIATED RATS. Pasotti, C.; Marchesani, F.; Coppi, M. (Univ., Pavia, Italy). Minerva Med.; 60: 4954-8(8 Dec 1969). (In Italian).

The effect of ellagic acid on the hemorrhage syndrome of irradiation was studied in rats by determination of the time and intensity of the bleeding using the De Nicola method. The rats were irradiated with a dose of 1000 R the first week and 200 R at the sixth and eighth week. The ellagic acid was administered by endovenous injection after the initial irradiation. The animals treated with ellagic acid showed a significant reduction of the hemorrhage time from the injection time up to 30 min and a clearly augmented value of the hemorrhage intensity. The results for 24 hrs are shown graphically and analyzed. (J.S.R.)

44537 SUNLIGHT INDUCED KILLING IN SACCHAROMYCES CEREVISIAE. Resnick, M. A. (National Inst. for Medical Research, London). Nature (London); 226: 377-8(25 Apr 1970).

It is stated that little is known about the nature of genetic damage produced by sunlight and whether there are cellular mechanisms for repairing the damage. The existence of cellular recovery systems has been demonstrated in a variety of organisms damaged by far-uv light, but this is not part of the sunlight spectrum at the Earth's surface. Studies are described on two types of uv sensitive mutants of yeast with a view to investigating whether the mechanisms available for the repair of uv damage can also act on sunlight induced lesions, the extent to which sunlight exposure is potentially lethal, and the nature of involved lesions. Excision repair, a stepwise process of removal and replacement of damaged DNA, and photoreactivation, a process in which photoreactivating enzyme attaches to uv induced pyrimidine dimers and splits them in the presence of visible light, were investigated. It was found that the effects of sunlight can be profound in the absence of genetic repair, and that pyrimidine dimers constitute a major category of the lesions, although other lesions may also be involved. It also appeared that the dark repair mechanism leaves no damage for photoreactivation, possibly because of a relatively slow exposure rate which allows more time for dark repair of pyrimidine dimers. The ability to photoreactivate pyrimidine dimers could therefore be relevant under conditions of growth (log phase) which do not leave sufficient time for dark repair. Although dark repair seems to be nearly 100% effective against lesions arising during short exposures to sunlight, killing does occur at higher doses. An observation that survival characteristics were similar on both sunny and hazy days suggests that there

is little attenuation of the component of sunlight that can cause killing. The findings may have important human implications, particularly with regard to xeroderma pigmentosum, a disease characterized by susceptibility to skin cancer after short exposures to sunlight. (UK)

Radiodiagnosis

Refer also to abstracts 44269, 44383, 44407, 44409, 44493, 44494, 44501, 44504–44506, 44525, and 44614.

44538 (CONF-691101–, pp 843-59) NEUTRON RADIOGRAPHY AND DOSIMETRY IN HUMANS: THEORETICAL STUDIES. Budinger, Thomas F. (California Univ., Berkeley. Lawrence Radiation Lab.); Howerton, Robert J.; Plechaty, Ernest F. (California Univ., Livermore. Lawrence Radiation Lab.).

Calculations using LRL-Livermore SORS Monte Carlo computer code and neutron cross-section library were done on a simulated human arm, including bone and marrow, for 1 keV, 120 keV, fission spectrum, and 14 MeV incident monoenergetic neutrons. These studies were done to analyze the dose distributed to bone and marrow, and to determine the feasibility of neutron radiography as a practical clinical tool. The resolution possible through tissues thicker than approximately 3 cm makes neutron radiography impractical except for possibly very special circumstances. The dose calculations reveal as much as a two-fold increase in dose deposited in the bone cortex compared to surrounding contiguous tissues. The skin dose is approximately two times greater than the dose 3 cm inside the tissue. The average energy absorbed in the arm on the basis of a fluence of one neutron incident per cm^2 is 0.5×10^{-10} rads, 1.6×10^{-10} rads, 10×10^{-10} rads, 40.4×10^{-10} rads, for 1 keV, 120 keV, fission spectrum and 14 MeV neutrons, respectively. (auth)

44539 MEDIASTINAL LYMPH NODE SCINTIGRAPHY IN ANIMALS BY INDIRECT ISOTOPE LYMPHOGRAPHY OF THE LUNGS. Langhammer, H.; Hertel, E.; Hoer, G.; Pabst, H. W. (Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed.; 111: 798-804(Dec 1969). (In German).

Using the present technique of intra-pulmonary or sub-mucous injection of ^{198}Au into the right lower lobe, most of the colloidal gold remains at the point of injection. Exact estimation of radioactivity in the mediastinum is therefore not possible. By means of animal experiments a method of indirect isotope lymphography of the lungs was developed that permits satisfactory scanning of the hilar and mediastinal lymph nodes. In order to get an accumulation of colloidal radio-gold in the mediastinual lymphatic system, it is necessary to inject it intrapleurally; this can be checked by appropriate scanning. The results were confirmed by in-vitro measurements and selective increase in radioactivity of the mediastinal lymph nodes was demonstrated. Differences in the results of intra-pulmonary and intrapleural injections were discussed and the possibilities of the clinical application of this method were indicated. (auth)

44540 ACCURACY OF ULTRASOUND MEASUREMENTS OF THE PELVIS AS COMPARED TO RADIOGRAPHY. Loch, Ernst-Gerhard; Strathmann, Joachim (Ruhr Univ., Bochum, Ger.). Strahlentherapie; 139: 459-61(Apr 1970). (In German).

Profile radiography (Guthman method) and ultrasonic B-scan profile (Vidoson) were made in 350 patients. The measurements from both methods were largely the same. The conjugata vera as measured by radiography was 11.8 ± 0.7 and by ultrasonic profile 11.5 ± 0.6 cm. The difference seemed to be due to the weak tissues lying near the pubic symphysis and the promontorium. Ultrasonics can largely replace the radiological methods with only a few exceptions. (auth)

44541 VALUE OF T_3 SUPPRESSION TEST AND THE 8th DAY ^{131}I UPTAKE IN EVALUATION OF THYROID FUNCTIONS. Erdogan, G. (Univ., Ankara). Ankara Univ. Tip. Fak. Mecm.; 21: 1051-62(1969).

Evaluation of thyroid functions, based solely on the 24 hr ^{131}I uptake, presents considerable difficulties. The 24 hr ^{131}I uptake values are found to be high in cases of both thyroid hyperfunction and thyroid deficiency. In order to be able to differentiate these, two methods that were cited in the literature have been used. The results indicated that these methods, whether they are applied together or separately, are insufficient to make the necessary differentiation. It was found that the T_3 suppression test and the 8th day uptake values, can be used in differentiating and following up cases with hyperactive nodules. (Excerpta Med.)

44542 HOT SPOTS IN LUNG SCANS. Preston, David F.; Greenlaw, Robert H. (Univ. of Kentucky, Lexington). J. Nucl. Med.; 11: 422-5(Jul 1970).

The rationale behind the appearance of hot spots in lung scans using ^{131}I-macroaggregated albumin (MAA) was investigated. In vitro studies were conducted to demonstrate the role of MAA in accelerating the blood clotting process and the active accumulation of MAA by the clot. The positive results in both cases led to the suggestion that in preparation for lung scanning using ^{131}I-MAA, blood should not be allowed to clot in the syringe. (E.R.B.)

44543 LIVER SCANNING ANALYSIS OF 2500 CASES OF AMEBIC HEPATIC ABSCESSES. Cuaron, Alfredo; Gordon, Felipe (Centro Medico Nacional, Mexico City). J. Nucl. Med.; 11: 435-9(Jul 1970).

A total of 3,379 liver scans was performed in 2,500 patients with proven hepatic amebic abscesses. Most of the patients suffered from only one abscess (83.0%) while 17% presented more than one lesion. A total of 4,286 abscesses was found. The most affected regions were those of the external half of the right hepatic lobe (65.0%), of the posterior portion of the right lobe (54.5%), and of the upper part of the same lobe (41.6%). The left lobe implanted only 21.4% of the lesions. Right lateral scans showed 72.2% of the lesions, while the anterior image demonstrated 92.8% and the posterior one depicted 94.6% of the abscesses. The combination of anterior and right lateral scans showed 95.5% of the abscesses. The posterior and right lateral scans showed 96.4% of the lesions and the anterior and posterior combination showed 97.1%. The combination of the three images demonstrated 98.6% of the abscesses. (auth)

44544 NUCLEAR MEDICINE TODAY. Brito, S. Medico (Oporto); 51: 369-72(1969). (In Portuguese).

A review is given of the use of radioisotopes in the diagnosis of diseases of the thyroid, brain, liver and lungs and to determine the site of placenta. (Excerpta Med.)

44545 RADIOISOTOPE ANGIOGRAPHY USING ^{113m}In–Fe–ASCORBIC ACID AND SCINTILLATION CAMERA. Hisada, Kinichi; Tonami, Norihisa (Kanazawa Univ., Japan). Jap. J. Clin. Radiol.; 14: 709-16(Sep 1969). (In Japanese).

Since November 1967, radioisotope angiography has been tried on about 120 cases, employing a scintillation camera, that contains a NaI crystal of 3 in. thickness and 12 in. diameter and a collimator having 1,000 holes, and ^{113m}In obtained from 50 mCi ^{113}Sn–^{113}In source. The conclusions obtained are as follows: ^{113m}In is an ideal nuclide for medical use, because its half-life is only 1.7 hr and it does not emit β rays. The effective period of ^{99}Mo–^{99m}Tc is only 10 to 14 days, but ^{113}Sn–^{113m}In can be employed for a long time. Moreover, there is little difference in the image obtained by scintillation cameras with ^{113m}In and ^{99m}Tc. In radioisotope angiography, rapidly changing radioisotope distributions can be depicted as a considerably clear image by injecting intravenously only 1 to 2 ml of radioisotope. On the other hand, in conventional angiography, morphological changes in the abdominal aorta cannot be clearly discerned even if 10 ml of contrast media are injected into the cubital vein. This angiography can be easily performed on serious cases such as cardiac insufficiency, iodine-sensitive patients, and child patients. It does not require any premedication or catheterization, and it can be performed in a short time. Moreover, it can be repeatedly performed every day. (NSA of Japan)

44546 ABSCESS DETECTION BY RADIOACTIVE CHROMIUM LABELED AUTOLOGOUS WHITE BLOOD CELLS. Deysine, Maximo; Robinson, Richard G.; Wilder, Joseph R. (Hospital for Joint Diseases and Medical Center, New York. Mount Sinai School of Medicine, New York). Surg. Gynecol. Obstet.; 131: 216-20(Aug 1970).

A method was developed for tagging experimental septic abscesses with ^{51}Cr labeled autologous leukocytes with minimal splenic, hepatic, or pulmonary contamination. The success of the method relies on autologous leukocytes; lack of red cell contamination; ascorbic acid deactivation of the nonwhite cell bound ^{51}Cr, and prevention of white blood cell clumping by heparin. The clinical potential of this method in the diagnosis of purulent collection is of importance. (auth)

44547 RENAL SCANNING FOR DETECTION OF RENOVASCULAR HYPERTENSION. DiOrio, Victor J. Jr.; Mishkin, Fred S. (Indiana Univ., Indianapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 769-75(Aug 1970).

The records of all 43 patients with hypertension who had ^{197}Hg-chlormerodrin kidney scanning performed during a 15 month period were reviewed. Performed without contrast enhancement, scans were interpreted as abnormal if one kidney or a segment of a kidney showed diminished activity when compared to the other Correlation of the results of the scans with the results of excretory urography, aortography, plasma renin assay, and surgical outcome showed that none of the 20 patients with normal scans

had surgically correctable renovascular hypertension, including one patient in whom all other screening studies were abnormal. Of the 23 patients with abnormal scans, good correlation with the aortogram was found in 19 of 20, with plasma renin assay results in 10 of 17, and in three of five patients who had split renal function studies. Of the seven patients who came to surgery for possible cure of renovascular hypertension, one had thrombosis of a renal artery graft. The scan correctly predicted the results found 5 to 11 months following surgery in the remaining six patients. It is concluded that the properly performed renal scan provides an often overlooked technically simple screening procedure for detecting renovascular hypertension. (auth)

44548 ABDOMINAL LYMPH NODE SCINTISCANNING WITH RADIOACTIVE GOLD (^{198}Au) FOR EVALUATION AND TREATMENT OF PATIENTS WITH LYMPHOMA. Pearlman, Alexander W. (New York Univ. Hospital for Joint Diseases and Medical Center, New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 780-92(Aug 1970).

Abdominal lymph node scintiscanning with ^{198}Au solutions is a simple physiologic test which yields clinically useful information in lymphoma patients. There is good anatomic and pathologic correlation between the scintiscan and the lymphangiogram. Scintiscanning has proved valuable in staging and treatment planning for lymphoma patients. Repeat scans during and after treatment have been useful in evaluation of the radiation response. Changes in the scan correlate well with serial studies of the opacified lymph nodes following lymphangiography. The presence of clinically silent unsuspected abdominal lymph node disease, demonstrated by a routine scintiscan, influences the management of the lymphoma patient. It is emphasized that scintiscanning for the lymphoma patient is intended primarily as a rapid screening procedure. When interpretation of the scan is uncertain, further studies including lymphangiography are mandatory. (auth)

44549 ADVANTAGES OF PRODUCING A MINIFIED SCAN IMAGE. Mishkin, Fred S.; Reese, Isaac C.; Dowell, James W. (Indiana Univ., Indianapolis. Veterans Administration Hospital, Indianapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 682-5(Aug 1970).

Minification of the image during radioisotope scanning results in readily recognizable patterns in a much shorter time than possible with the production of a life-sized image, with no loss of resolution of the scanning system. The same results are not possible simply by reducing a rapidly made large image to a smaller image, although the size reduction may make interpretation simpler. A further advantage of the minified image should be found in economy of film and storage space. By reproducing images on 70 mm or 8 × 10 inch film instead of standard 14 × 17 inch roentgenographic film, cost may be reduced and storage problems simplified. (auth)

44550 GHOST IMAGES AS ARTIFACTS IN GAMMA CAMERA SCANS. Bramlet, Roland C. (Highland Hospital, Rochester, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 676-81(Aug 1970).

A situation is reported where a ghost image and other collimator artifacts appeared in a gamma camera scan. It is proposed that such artifacts may be eliminated by providing a suitable type of motion of the collimator between the observed source and the detector during image formation. This proposal is supported by a spatial wave form analysis and by an experimental demonstration of the moving collimator principle. Other possible means of collimator artifact elimination are discussed and compared. (auth)

44551 PERFUSION BRAIN SCANS AND THE ANATOMIC LESIONS ENCOUNTERED: A CORRELATION. Briz-Kanafani, Santos; Garcia-Montemayor, Esteban (National Inst. of Neurology of the Ministry of Health and Welfare, Mexico City). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 686-91(Aug 1970).

Perfusion macroaggregate brain scanning is now a routine diagnostic method. Results of more than 200 such studies using human albumin macroaggregates labeled with ^{131}I are reviewed and results in 24 of these patients who were subsequently studied at autopsy are discussed. The gross and microscopic features of the lesions found are described and compared with the brain scan impression. No signs were noted which would indicate that this technique might bring about damage to the brain parenchyma. (auth)

44552 EXPERIENCE WITH PARATHYROID SCINTIGRAPHY. Centi Colella, A.; Pigorini, F. (Univ., Rome). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 714-23(Aug 1970).

After a short review of the actual possibilities of parathyroid visualization with radioisotopes, experience using ^{75}Se-selenomethionine scanning in 34 patients suffering from primary hyperparathyroidism is reported. Preoperative exact localization of hyperfunctioning parathyroid tissue was achieved in 53% of the controlled patients. Biologic and physical factors, affecting the visualization of parathyroid tissue, are discussed. (C.H.)

44553 JEJUNAL INTUSSUSCEPTION DEMONSTRATED BY ^{99m}Tc PERTECHNETATE AND ABDOMINAL SCANNING. Duszynski, Diana O.; Anthone, Roland (Children's Hospital, Buffalo). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 729-32(Aug 1970).

A patient with gastrointestinal bleeding suspected of being caused by Meckel's diverticulum was studied. A jejunal intussusception secondary to polyps of the Peutz-Jeghers type was demonstrated by the intravenous administration of ^{99m}Tc–Na pertechnetate and subsequent abdominal scanning. (auth)

44554 ACCURACY OF LIVER PHOTOSCANS. Covington, E. Eugene (Memorial Hospital, New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 742-4(Aug 1970).

One thousand liver photoscans were analyzed, 410 called normal and 203 called positive, but without positive proof of accuracy. It is concluded that the accuracy of photoscanning in this group is fairly high. A positive proof (biopsy, operation, or autopsy) of accuracy was obtained on 387 photoscans. Aspiration biopsy proved photoscanning accurate in 87%, abdominal operation proved the accuracy in 71%, and autopsy proved the accuracy in 72%. The diagnosis was missed in 107 (27.6%) of these 387 cases. The most common causes for false positive diagnoses and for false negative diagnoses are discussed. (C.H.)

44555 ^{85}Sr SCINTIMETRY OF THE HIP IN OSTEONECROSIS. AND OSTEONECROSIS. Crutchlow, William P. (New York Hospital, Cornell Univ., New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 803-12(Aug 1970).

Strontium-85 scintimetry was performed on 195 hips in 116 patients who were classified as being normal or having superior, medial, or mixed osteoarthritis, and osteonecrosis with and without secondary osteoarthritis. Evidence is presented to suggest that ^{85}Sr scintimetry may be useful in demonstrating early osteoarthritis prior to its roentgenographic appearance, and that some cases of idiopathic osteoarthritis may indeed be caused by a prior episode of spontaneous osteonecrosis. (auth)

44556 ^{87m}Sr SCANS IN CHILDREN WITH EXTRAOSSEOUS PATHOLOGY. Samuels, L. D. (Ohio State Univ., Columbus). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 813-19 (Aug 1970).

Metastable strontium-87 scannings were performed of all or parts of the skeleton of children with a variety of tumors not arising in bone. The presence of soft tissue malignancy contiguous to bone may evoke a malignant type ^{87m}Sr uptake pattern in bone even though the malignancy does not demonstrably involve bone. Examples of malignancies of brain, neck, pelvis, and foot which presented positive scans are illustrated, as is the generalized abnormal uptake characteristic of acute leukemia. Wider and earlier diagnostic use of the ^{87m}Sr skeletal scan in screening for cancer in children is suggested. (auth)

44557 AUTOMATION IN THE NUCLEAR MEDICINE LABORATORY: AN ALGORITHM FOR INTERPOLATION ON A 5 POINT STANDARD CURVE. Nusynowitz, Martin L. (William Beaumont General Hospital, El Paso, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 835-8(Aug 1970).

The construction of a standard curve from which the results of a series of specimens are determined is a time consuming but commonly encountered laboratory process. An algorithm for the total automation of this procedure is presented. When used with a desk top digital computer, the standard curve is mathematically constructed, data are automatically read in, the appropriate region of the curve is utilized to derive the solution, and the answer is automatically printed out. Advantages of such a program include speed, accuracy, and legibility of results. The program is adaptable to a variety of commonly encountered problems in nuclear medicine. (auth)

44558 PREDICTABILITY OF RED CELL VOLUME FROM RISA BLOOD VOLUME. Nusynowitz, Martin L.; Strader III, Wilbur J.; Waliszewski, Jerome A. (William Beaumont General Hospital, El Paso, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 820-2(Aug 1970).

The RISA plasma label method of estimating red cell volume is technically simple, rapid, adaptable to automation, and can be performed repeatedly, but has been criticized because of discrepancies in individual results when compared to ^{51}Cr cell label methods.

Determinations in 33 patients have shown an extremely high degree of correlation between both methods (r = +0.974), attesting to the predictability of one from the other. Most of the discrepancies in results were quite small, and none was so great as to negate its clinical usefulness. The simpler RISA method of red cell volume estimation is very adequate for most clinical purposes. (auth)

44559 DIAGNOSIS OF SPLENIC INFARCTION BY SCINTILLATION SCANNING WITH ^{203}Hg-BROMOMERCURIHYDROXYPROPANE (^{203}Hg-BMHP). Alarcon-Segovia, Donato; Mayorga-Cortes, Alvaro; Gonzalez-Jimenez, Yolanda; Maisterrena, Jorge (Instituto Nacional de la Nutricion, Mexico City). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 761-3(Aug 1970).

The confirmation of the clinical diagnosis of splenic infarction by means of scintiscanning with ^{203}Hg-labeled erythrocytes treated with bromomercurihydroxypropane is reported for two patients. The diagnosis was later proven histologically. (C.H.)

44560 DUAL ISOTOPE PANCREATIC IMAGING UTILIZING THE ANGER CAMERA AND ^{99m}Tc SULFUR COLLOID. Bergeron, D.A.; Vogel, John M. (Public Health Service Hospital, San Francisco). Amer. J. Roentgenol., Radium Ther. Nucl. Med; 109: 764-8(Aug 1970).

A method of visualization of the pancreas with the Anger camera is evaluated. The Anger camera was coupled to a 4096 channel analyzer and tape data storage. The radioisotopes used were ^{75}Se-selenomethionine and ^{99m}Tc as the sulfur colloid. The dual isotopes allowed subtraction techniques to be applied which eliminated interference by the hepatic image. Further enhancement of the pancreatic image was accomplished by the use of a Z modulated oscilloscope. The method provides improved visualization of the pancreas by elimination of the hepatic image. (auth)

44561 ROLE OF GAMMACINEMATOGRAPHY IN THYROID SURGERY. Tuohimaa, E. (Central Hospital of Tampere, Finland). Ann. Chir. Gynaecol. Fenn., Suppl.; 58: No. 166, 13p(1969).

A description is given of 53 patients with goitre treated with surgery, 40 toxic and 13 nontoxic cases. Gamma camera images were made postoperatively of all the patients, further, of the toxic ones before the preoperative medication and of the nontoxic ones immediately before operation. Conclusions are: gammacinematography visualizes well the active and hypoactive regions and nodules of the thyroid, although it cannot distinguish a toxic multinodular goitre from a nontoxic case. The method can demonstrate the pre- and postoperative activity of the thyroid and is a valuable aid to the dosage of pre- and postoperative medication required in cases of goitre. One can clearly see the inhibitory action of preoperative carbimazole and iodine treatment, and the restraining action of postoperative thyroxine therapy on the thyroid remnants. By means of successive gamma camera images the patient can be followed up and the postoperative dosage of thyroxine accurately judged. (Finland)

44562 LYMPHORETICULAR SARCOMAS WITH PRIMARY INVOLVEMENT OF WALDEYER'S RING. CLINICAL EVALUATION OF 225 CASES. Banfi, Alberto (National Cancer Inst., Milan); Bonadonna, Gianni; Carnevali, Giuseppe; Molinari, Roberto; Monfardini, Silvio; Salvini, Enea. Cancer; 26: 341-51(Aug 1970).

A total of 225 consecutive untreated patients with lymphoreticular sarcomas with primary involvement of Waldeyer's ring was evaluated (151 without lymphography and 74 with lymphography). On admission, the anatomical distribution of the primary growth within Waldeyer's ring was as follows: tonsil, 40%; nasopharynx, 27.5%; base of tongue, 2.7%; soft palate, 2.7%; oropharynx, 0.9%; other sites, 26.2%. In the group studied without lymphography, the disease was confined to Waldeyer's ring in 22.5% of cases and had spread to the cervical nodes in 62.3% and to distant nodes in 15.2%. In the group studied more recently with lymphography, these figures were 13.5%, 41.9%, and 44.6%, respectively. At the time of initial evaluation, the lymphoma involved extranodal sites in only 24 of 225. In the 74 cases evaluated with lymphography, the mode of spread was studied by observing the first site of recurrence after radiotherapy. New manifestations occurred in most patients within 2 yr from the end of treatment and preferentially in extranodal sites. The involvement of the gastointestinal tract, either at the time of admission or early in the follow-up, was 20% in the group studied with lymphography. The possibility that a certain number of lymphoreticular sarcomas could arise concomitantly in Waldeyer's ring and in the gastrointestinal tract is discussed. (auth)

44563 RADIOLOGICAL DIAGNOSIS OF OCCULT NORMAL-PRESSURE HYDROCEPHALUS. LeMay, Marjorie; New, Paul F. J. (Massachusetts General Hospital, Boston. Boston Veterans Administration Hospital. Beth Israel Hospital, Boston. Harvard Univ., Boston. Boston Univ.). Radiology; 96: 347-58(Aug 1970).

Radiological findings were reviewed in 41 patients with ventricular shunts because of a diagnosis of occult normal cerebrospinal fluid (CSF) pressure hydrocephalus (NPH). Findings included enlargement of the anterior portion of the lateral ventricle, corpus callosal angle of 120° or less on the anteroposterior film with the patient supine, and wide basilar cisterns with abrupt obstruction of upward gas flow. On cisternography, early and persistent radioactivity in the ventricles and failure of isotope concentration in parasagittal areas was seen. Delay in the rise of the isotope to the parasagittal regions may suggest atrophy. Cerebral angiography in patients with NPH shows findings characteristic of obstructive hydrocephalus. (auth)

44564 SPLEEN SCANNING USING ACID-DAMAGED RED CELLS TAGGED WITH ^{51}Cr. Mayer, Klaus; Dwyer, Andrea; Laughlin, John S. (Sloan-Kettering Inst. for Cancer Research, New York). J. Nucl. Med.; 11: 455-8(Jul 1970).

A procedure using acid-citrate dextrose (ACD) as a red-cell damaging agent to define the location of the spleen is described: Using ^{51}Cr-chromate to label the ACD-damaged cells, it was shown that the damaged cells, upon recirculation, were concentrated in the spleen, liver, and marrow. Thus, a reliable spleen scan could be obtained locating, defining, and determining the size of the organ. Documentation of the size and shape of the spleen may be a valuable adjunct to evaluation of standard and experimental therapy. (E.R.B.)

44565 SERIAL SCANS OF LIVER REGENERATION AFTER HEMIHEPATECTOMY IN CHILDREN. Samuels, L. D.; Grosfeld, J. L. (Ohio State Univ., Columbus. Children's Hospital, Columbus, Ohio). Surg. Gynecol. Obstet.; 131: 453-7(Sep 1970).

Liver scans, as part of a series of multiple organ scans in the diagnosis of abdominal masses, should be repeated shortly after operation and at frequent intervals thereafter, until regeneration to expected normal size has occurred. Thereafter, serial scans are most useful in detecting late complications of either the disease or of the operative procedure, as well as being useful in evaluating possible effects of radiation therapy if this modality is also used. (auth)

44566 COMPARISON OF TECHNIQUES FOR OBTAINING THE VERTEX VIEW IN BRAIN SCANNING. Gilday, D. L.; Reba, R. C.; Longo, R. (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Med.; 11: 503-7(Aug 1970).

The technical quality and information obtained from vertex views performed with a 5-in rectilinear scanner and an Anger camera after the injection of ^{99m}Tc-pertechnetate and 1 mg of atropine were compared. The images from the rectilinear scanner were better in 30 of the 50 cases and equal in 18. Comparison of early (10-min) and late (60 to 90-min) vertex views performed when atropine could not be administered was also carried out. The early vertex views were better in 21 of the 50 cases and equal in 25. The optimum vertex view is best performed after premedication with atropine and potassium perchlorate using a rectilinear scanner. If the patient cannot receive atropine, then a camera vertex view obtained shortly (10 to 15 min) after the injection of ^{99m}Tc-pertechnetate is more likely to be helpful than a late (60 to 90-min) vertex view. (auth)

Radiotherapy

Refer also to abstracts 44512, 44513, 44517, 44610, 44611, 44620, 45626, and 45645.

44567 CLINICAL PROBLEMS CONCERNING PRIMARY CARCINOMA OF THE FALLOPIAN TUBES. Csoemoer, Sandor; Toth, Ferenc; Szeker, Janos (Medizinische Univ., Budapest). Strahlentherapie; 139: 404-9(Apr 1970). (In German).

Symptoms, diagnostic problems, and principles of surgical and radiological treatment of carcinoma of the tubes are discussed, after reviewing 24 cases of the last 23 years. If the classic diagnostic methods do not clarify a clinical problem, an exploratory laparotomy is indicated. Treatment results depend primarily on early diagnosis. (auth)

44568 APPLICATION OF MEDIUM-FAST ELECTRONS IN RADIOTHERAPY. Wachsmann, Felix (Gesellschaft fuer Strahlenforschung mbH, Munich). Strahlentherapie; 139: 385-8 (Apr 1970). (In German).

Monochromatic electrons are very adequate for a homogenous irradiation of skin diseases. They furthermore have a sparing

effect on underlying tissues. A comparison with soft x-rays and in homogenous radionuclide beta-rays shows the superiority of accelerator electrons. In order to irradiate homogenously a thickness of 0.5 to 7 mm, electrons of 0.5 to 3 MeV are needed, taking into account the absorption in the accelerator window and in the air traversed. For thickness of 12 mm (skin tumors), electrons of 5 MeV are appropriate. Dose-rate for the mean electron current for various fields and their technical solutions are discussed. The possible therapeutic effects and economic problems are outlined. (auth)

44569 METHOD OF ELECTRON PENDULUM RADIATION FOR BLADDER CARCINOMAS. Schmidt-Hermes, Heinz Josef; Sommer, Franz; Schnaudigel, Otto-Ernst (Univ., Homburg, Ger.). Strahlentherapie; 139: 389-96(Apr 1970). (In German).

A pendular irradiation technique with electrons for bladder carcinomas is described. The technique is discussed based on measurements in water and in the Alderson phantom. (auth)

44570 SYNERGISTIC EFFECTS OF X-RAYS AND DRUGS ON A HUMAN TUMOR XENOGRAFT, GW-39. Goldenberg, David M.; Ammersdoerfer, Erika (Univ. of Pittsburgh). Eur. J. Cancer; 6: 73-80(1970).

A human colonic carcinoma serially transplantable in cheek pouches of adult, unconditioned, golden hamsters, GW-39, was relatively unresponsive either to x irradiation or drug therapy. Upon irradiation of one cheek pouch tumor in shielded animals, no systemic or abscopal growth-inhibitory effects on the opposite cheek pouch tumor were observed. Combinations of 300 R x rays and either actinomycin C, cyclophosphamide, 5-fluorouracil, podophyllic acid ethyl hydrazide, or procarbazine hydrochloride yield comparable synergism of antitumor effects in this tumor system when low doses of each modality are given. It appears that the primary mechanisms of action of these different drugs is not of consequence in determining their possible synergism with x irradiation. These results suggest that the most active drug in a particular kind of cancer be combined, at a low dose level, with modest quantities of irradiation, even in neoplasms of a chemo- or radioresistant nature, such as colonic cancer. (auth) (UK)

44571 TRANSLATION PENDULUM RADIATION WITH FAST ELECTRONS FOR THERAPY OF MAMMARY CARCINOMAS. Alth, G.; Hawliczek, F. (Krankenhauses der Barmherzigen, Schwestern, Linz, Ger.). Strahlentherapie; 139: 397-403(Apr 1970). (In German).

A new irradiation technique with electrons for breast cancer is described. This method of translation and pendular movement allows to obtain a homogenous dose in the irradiated region, the parasternal lymph nodes, and the cervical region. The observed complications are reported: radiation pneumonitis and general reactions. Association of electrons with x-rays should be disregarded. (auth)

44572 CYTOLOGICAL CHANGES IN UTERINE CANCER DUE TO LINEAR IRRADIATION. Yamada, Isao (Aomori Prefectural Central Hospital, Japan); Takamura, Ikuyo. Aomori Kenritsu Chuo Byoin Ishi; 14: 133-44(Mar 1969). (In Japanese).

The effect of radiotherapy using a linear accelerator on malignant uterine cancer was evaluated on the basis of cytological and histological changes. The patients received a daily dose of 200 R, the total being 5,000 R to 6,000 R. The measurement of tumor size, examinations of smear, and biopsy (or test curettage) were performed at every 1,000 R for comparative studies. The reaction of tumor cells to radiation started at 1,000 R with marked swelling of the cell nucleus and vacuolar degeneration, followed by cytolysis at 2,000 R, that became marked at 3,000 R with necrocytosis, and finally at 4,000 R almost no tumor cells were recognized. The changes in normal cells appeared later, starting with 3,000 to 4,000 R. In accordance with Graham's radiation response, the reaction time of normal epithelial cells corresponded to that of tumor cells. Adenocarcinoma is usually considered to be less reactive than squamous cell carcinoma. However, no distinctive difference was observed with 1,000 R and 2,000 R. The marginal area of tumors (undifferentiated cells) was found to be more sensitive compared with the central area (differentiated cells). (NSA of Japan)

44573 RAPID CONTROL OF MASSIVE HEPATIC HEMORRHAGE BY LASER RADIATION. Gonzalez, Ricardo; Edlich, Richard F.; Bredemeier, H. C.; Polanyi, Thomas G.; Goodale, Robert L.; Wangensteen, Owen H. Surg. Gynecol. Obstet.; 131: 198-200(Aug 1970).

This experimental study indicates the value of laser radiation in controlling bleeding from the raw surface of the liver. In the control dogs as well as in dogs with prolonged bleeding induced by heparin, hemostasis of the bleeding liver was rapidly achieved by laser radiation. Laser radiation proved to be a more effective hemostatic agent than electrocoagulation in controlling hemorrhage from the liver. These results suggest that the continuous wave carbon dioxide laser warrants clinical trial in massive hemorrhage from the liver in man. The method would appear to present distinct advantages over the currently available techniques. (auth)

44574 WILMS' TUMOR: PREOPERATIVE RADIOTHERAPY AND CHEMOTHERAPY IN THE MANAGEMENT OF MASSIVE TUMORS. Wagget, J.; Koop, C. E. (Children's Hospital of Philadelphia). Cancer; 26: 338-40(Aug 1970).

Preoperative treatment with chemotherapy and radiotherapy was carried out in 12 cases of massive Wilms' tumor between January 1962 and December 1968. Six cases had pulmonary metastases at the time of diagnosis, and, in 8 of 12 cases there was spread beyond the renal capsule. No adverse affects from the treatment were noted. Three patients are dead and 9 are alive and free of disease–7 for more than 2 yr and 2 for more than 14 months. This method of treatment is suggested for selected cases with massive tumors. (auth)

44575 SPONTANEOUS REGRESSION OF PULMONARY METASTASES FROM TRANSITIONAL CELL CARCINOMA OF THE BLADDER. Lome, Leon G. (Boston City Hospital); Navani, Shiv; Aral, Isamettin M. Cancer; 26: 415-18(Aug 1970).

A case of regression of pulmonary metastases from transitional cell carcinoma of the bladder is presented. The lung nodules disappeared following a course of radiotherapy to the urinary bladder. The possibility that their disappearance was due to an abscopal effect is discussed. To our knowledge, this is the first case reported of regression of pulmonary metastases from transitional cell carcinoma. (auth)

44576 ROLE OF RADIATION THERAPY IN THE PRIMARY MANAGEMENT OF BREAST CANCER. Fletcher, Gilbert H.; Montague, Eleanor D.; White, Edgar C. Progr. Clin. Cancer; 4: 242-56(1970).

Pre- or postoperative irradiation of the peripheral lymphatics with doses of 4000 to 5000 rads given in 4 weeks with ^{137}Cs or ^{60}Co has reduced the incidence of supraclavicular recurrences to 2% in patients with positive axillary nodes in surgical specimens. Parasternal nodules have almost never occurred. These data are evidence of the effectiveness of the irradiation in eradicating subclinical aggregates of cancer. In patients with inner quadrant or central lesions, or with lesions of the outer quadrants with axillary nodes positive, the surgical specimens demonstrate a probability of existing subclinical disease in one or both of these areas of no less than 25% and in some cases as high as 50%. Irradiation of the peripheral lymphatics, with a complication-free technic, is indicated. Radical irradiation with or without simple mastectomy produces a high percentage of local control in the locally advanced cases. It also secures permanent cures, 22% of the patients with simple mastectomy followed by radical irradiation being alive at 10 yr. (auth)

44577 THE USE OF ^{32}P IN HEMATOLOGICAL DISEASES. Arini, Elsa (Instituto de Investigaciones Hematologicas, Buenos Aires). Medicina (Buenos Aires), Suppl.; 28: No. 1, 61-70 (Dec 1968). (In Spanish).

Therapeutic results obtained with ^{32}P in 262 cases of hematological affections from 1942 onward are presented; these include 65 cases of chronic myeloid leukemia, 48 cases of acute leukemia and 31 cases of polycythemia. In patients with polycythemia the results are similar to those obtained with teleroentgentherapy. During the treatment, and as the number of RBC decreased, the intensity of the phosphatase reaction in the neutrophils also decreased, which could be used as an evaluation of the efficiency of the therapy. Out of a total of 31 cases, very good results were obtained in 64.5% of the patients. The longest remission was 4 years, 9 months. The causes of death in 5 cases were: 2 due to acute leukemia, 2 to bone marrow aplasia and 1 to pulmonary embolism. Out of the patients still under observation, some have surpassed 127 months of survival. In chronic myeloid leukemia patients without previous treatment, a good response was obtained in 15 cases, moderate in 5, and negative in 1. The doses varied from 6 to 9 mc. In patients with good remissions, these lasted between 8 and 32 months. The results are similar to those obtained with radiotherapy. In acute leukemias, ^{32}I was used before the appearance of chemotherapy in 30 children. In 10 it was used as initial therapy obtaining some good remissions: 1 of 23 months, 2 of 7 months and 2 of 2 months. Unequal results were obtained in 65 cases of chronic lymphoid leukemia. In some cases, long and efficient remissions (one of 54 months) were obtained. In 39 cases in which ^{32}P was used as initial therapy, very good remissions were obtained in 13 cases, good in 18, moderate in 4 and negative in 2. (auth)

44578 PION CANCER THERAPY: POSITRON ACTIVITY AS AN INDICATOR OF DEPTH-DOSE. Taylor, M. C.; Phillips, G. C.; Young, R. C. (Columbia Scientific Research Inst., Houston, Tex.). Science; 169: 377-8(24 Jul 1970).

Negative pions are useful for radiotherapy of localized carcinoma because of their large end-of-range energy deposition upon capture in nuclei and the potentially accurate spatial localization of the radiation dose. Accurate determination of the depth of penetration of the pion beam in vivo can be accomplished by counting the back-to-back annihilation γ rays resulting from positron activity induced by the stopped pions. (auth)

44579 RADIOBIOLOGY'S CONTRIBUTION TO RADIOTHERAPY: PROMISE OR MIRAGE? FAILLA MEMORIAL LECTURE. Kaplan, Henry S. (Stanford Univ., Calif.). Radiat. Res.; 43: 460-76(Aug 1970).

The contributions from radiobiological research to the field of clinical radiotherapy are discussed. Highlights of the historical development of radiotherapy are presented along with the more significant contributions of the radiobiologists to this development. An appeal for the continued application of new radiobiological techniques and the latest results of radiobiological research in clinical radiotherapy is also made. (E.R.B.)

44580 ULTRASONIC SCANNING IN RADIOTHERAPY TREATMENT PLANNING. Smith, Edward H.; Holm, Hans H. (Gentofte Hospital, Copenhagen). Radiology; 96: 433-5(Aug 1970).

Ultrasonic scanning offers an accurate, atraumatic, and reproducible method for obtaining true anatomical cross-sections of a tumor, surrounding normal tissues, and the external body contour in patients undergoing radiation therapy. The application of isodose curves to the calculation of radiation dose is both easier and more accurate. (auth)

Blast and Thermal Effects

44581 CONTRIBUTION TO THE WORK OF THE ATOMIC BOMB CASUALTY COMMISSION (ABCC). Cannan, R. Keith (National Research Council, Washington, D. C.). Arch. Environ. Health; 21: 263-6(Sep 1970).

The scope and activities of the Unified Study Program are discussed. The program, which was proposed and implemented through the efforts of Dr. Thomas Francis, was to supplement the efforts of the Atomic Bomb Casualty Commission in their attempts to determine the effects of the Hiroshima and Nagasaki bombings on the human population. The success of the program in accumulating data on the study and control groups to date is discussed. (E.R.B.)

Radiation Effects on Animals

Refer also to abstracts 44387 and 44425.

44582 (EUR-4452, pp 83-105) LOCAL ENERGY DENSITY REQUIREMENTS FOR BIOLOGICAL RADIATION DAMAGE AND THEIR MODIFICATION BY ENVIRONMENTAL CONDITIONS. Barendsen, G. W. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut).

Characteristics of relations between the relative biological effectiveness of different ionizing radiations and the spatial distributions of energy dissipation in irradiated cells can be interpreted by the assumption that for the induction of various types of damage in cells, energy absorption is required at local energy densities which must exceed a minimum value. These high local energy densities initiate the chain of events which finally results in the end-point observed. A variety of factors is known to be capable of modifying the effectiveness of a given dose of ionizing radiation for producing biological damage. For radiations which mainly produce very high local energy densities, the effectiveness per unit dose for producing a given biological end-point is less dependent on various environmental conditions than the effectiveness of radiations which deposit most of the energy at low energy densities. The relation between the magnitude of the modification by oxygen and the variation in local energy density requirements is discussed. It is concluded that differences exist, depending on the end-point measured. (auth)

44583 ALTERATION OF ERYTHROCYTE VOLUME FOLLOWING X IRRADIATION. APPLICATION OF AUTOMATIC PROCEDURES FOR INVESTIGATIONS OF MEAN VOLUME AND SIZE DISTRIBUTION OF BLOOD CELLS ON MEMBRANE IRRADIATED ERYTHROCYTES. Schuett, P.; Fox, J. M. (Medizinische Akademie, Luebeck, Ger.). Strahlentherapie; 139: 465-71(Apr 1970). (In German).

An experimental damage of the membrane of erythrocytes was followed by a change of the mean volume of the cells. It was shown that the electrical methods of measurement of the cell size also may be applied to such measurements using non-fixing suspensions to the red cells. The physiological solution by Straub showed the best properties with regard to absolute determination of the mean volume of erythrocytes. Relative measurements may also be done with the physiological solution after Locke. The mean volume of human erythrocytes decreased after irradiation by x-rays (500 R, 60 kV, 1 mm Al) by about 4.3% of the original value. This result was gained by measurement of the samples of blood from 263 test persons. It showed individual variations. The permeability for potassium was selectively increased by the radiation induced oxidation of the sulfhydryl groups of the erythrocyte membrane, so that a loss of potassium from the red cells and consequently a decrease of the mean volume of the cells resulted. (auth)

44584 RADIOSENSITIVITY AND THE OXYGEN EFFECT FOR MAMMALIAN CELLS CULTURED IN VITRO IN STATIONARY PHASE. Berry, Roger J.; Hall, Eric J.; Cavanagh, Josephine (Churchill Hosp., Oxford). Brit. J. Radiol.; 43: 81-90(Feb 1970).

HeLa cells grown in medium 199 supplemented with 15% human serum showed increased radiosensitivity when irradiated in unfed confluent culture (stationary phase), compared with their response when irradiated during exponential growth (log phase). In addition, a biphasic dose-response curve for stationary phase cells irradiated under hypoxic conditions indicates that the oxygen enhancement ratio (OER) was reduced from circa 3.0 to circa 1.8 for a significant proportion of the cells. Thus, up to doses of 500 to 600 rads, greater depopulation occurred in hypoxic stationary phase cells than in aerobic, exponentially growing cells. However, the same cells grown in human serum-supplemented medium F10 showed increased radiosensitivity in confluent culture but an unaltered OER. By contrast, Chinese hamster cells grown in confluent culture with or without medium changes showed no significant changes in the slope or shoulder of their dose-survival curves compared with those irradiated during exponential growth, and no alteration in OER. If the stationary phase 199-grown HeLa cells in their folic acid-deficient, thymidine-deficient, asparagine-deficient medium are a suitable model for the hypoxic and metabolically starved tumour cell at a distance from a capillary blood supply, their unexpected radiosensitivity and reduced response to hypoxia could explain why fractionated-dose radiotherapy does cure many human tumours. (auth) (UK)

Invertebrates

Refer also to abstracts 44641, 44648, 44649, and 44651.

44585 STUDIES ON NATURAL POPULATIONS OF DROSOPHILA. VII. EGG PRODUCTION IN NATURAL AND X-IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER IN RELATION TO GEOGRAPHICAL DISTRIBUTION. Tantawy, A. O.; Nasrat, G. E.; Saad, F. F. (Cairo Univ., Giza, Egypt). Isotope Radiat. Res.; 2: 39-47(Jun 1969).

Natural populations of Drosophila melanogaster from five different geographical regions, i.e., Scotland (SC), Germany (GM), Japan (JP), Egypt (UF) and South Africa (SA) were used in the present study to investigate egg production and the effects of x-irradiation on such a character. Males and virgin females (both 3 days old) were subjected to three doses of x ray, i.e., 1500, 3000, and 4500 R, and after irradiation the following matings were carried out: a) Irradiated males × untreated females, b) Irradiated males × irradiated females, c) Untreated males × irradiated females and, d) Untreated males × untreated females (controls). The following results were obtained: Egg production in the untreated natural populations arranged in a decreasing order was as follows: GM (35.59), JP (35.09), SC (32.91), UF (24.50), and SA (24.24) eggs per female per day. Egg production in the first three populations (northern populations) was significantly higher than in the other two populations (southern populations). Irradiation of the male parent only showed no significant effects on egg production, while irradiation of the female parent caused a significant reduction. The differences between northern populations and the southern ones remained after irradiation. (auth)

44586 EFFECTS OF GAMMA RADIATION ON EGG AND LARVAL DEVELOPMENT OF THE COTTON LEAF WORM SPODOPTERA LITTORALIS BOISD. Zaki, M. M.; El-Badry, E. A.; Wakid, A. M.; Souka, S. R. (Atomic Energy Establishment, Cairo). Isotope Radiat. Res.; 2: 33-8(Jun 1969).

When young and old eggs of Spodoptera littoralis Boisd. were directly irradiated by different doses of γ rays, their mortalities increased with increasing dose. However, old eggs were more resistant than young ones. Lethality during the larval stage and the difficulty of adults to emerge increased with the increase of dose. Irradiation of first, third, and fifth instar larvae delayed

their development and their mortalities increased with the increase of the dose. It was noted that old eggs were more resistant to γ radiation than larvae. (auth)

44587 EFFECT OF ^{137}Cs GAMMA RAYS ON REGENERATION IN TUBULARIA. Slaughter, Margaret; Rose, Florence C.; Liuzzi, Anthony (Yale Univ., New Haven. Tulane Univ., New Orleans. Marine Biological Lab., Woods Hole, Mass.). Biol. Bull.; 138: 194-9(Apr 1970).

Short tentacles developed on hydranths regenerated from stems of Tubularia exposed to ^{137}Cs γ irradiation at exposure levels of 10,000 R and 20,000 R. Those hydranths that did regenerate from irradiated stems tended to drop off sooner than hydranths regenerated from un-irradiated stems. Exposures of 150,000 R and 200,000 R completely stop regeneration in Tubularia; 300,000 R is fatal to the organism. The observed delay in time of regeneration increased as the exposure levels increased and thus appeared to be dose dependent. (auth)

44588 RADIATION LIFE SHORTENING IN DROSOPHILA AS A FUNCTION OF AGE AND PRIOR EXPOSURE. Blair, H. A.; Baxter, R. C. (Univ. of Rochester, N. Y.). Radiat. Res.; 43: 439-51(Aug 1970). (UR-49-1172).

The after-survivals S of adult Drosophila melanogaster exposed to the same dose of 250 kV x rays at various ages are constant fractions k of the remaining life expectancies E at those ages. The value of k is the same, also, if the life expectancy has been reduced by a prior dose or by such dose along with additional aging. The fraction k decreases as the dose R increases, and the present data are compatible with such general relations as $\log k = \log(S/E) = -0.0036(R + 0.025R^2)$ or $\frac{1}{2}(1/k) = (E/S) = 1 + 0.0043(R + 0.025R^2)$. The values of the constants are probably dependent on the quality of the radiation. (auth)

44589 MATING FREQUENCY AND FERTILITY OF MEDITERRANEAN FRUIT FLY FEMALES ALTERNATELY MATED WITH NORMAL AND IRRADIATED MALES. Katiyar, K. P.; Ramirez, E. (Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica). J. Econ. Entomol.; 63: 1247-50(Aug 1970).

When female Ceratitis capitata (Wiedemann) initially mated with normal or irradiated (10 kR) males, were repeatedly allowed to remate up to 22 days of age with opposite types of males, 41.3% females remated with normal males and 26.7% remated with irradiated males. The effect of the 2nd mating on female fertility is independent of the time interval between the 1st and 2nd matings. Fertility of females alternately mated to both types of males increased by 68.2% when the last mating was with normal males and decreased by 43.4% when the last mating was with irradiated males. Fertility of females that did not remate within 7 days was only slightly affected when these females were caged for 2 weeks with males opposite to the type employed in the initial matings. (auth)

Vertebrates

Refer also to abstracts 44385, 44386, 44426, 44427, 44430, 44432, 44434, 44438, 44442–44452, 44462, 44531–44533, 44535, 44536, and 44573.

44590 (EUR-4452, pp 761-78) THE RELATION BETWEEN MOUSE LETHALITY AND ENERGY DEPOSITION BY SECONDARY PARTICLES FROM NEUTRONS AND X-RAYS. Broerse, J. J.; van Putten, L. M.; Barendsen, G. W. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut).

The absorbed doses of fast neutrons and electromagnetic radiation depend on the atomic composition of the tissue in which energy is deposited. In previous experiments perturbations in secondary particle equilibrium for neutron- and x-irradiations have been measured at interfaces of bone- and soft tissue-equivalent plastic respectively and the results have been related to the RBE of 15 MeV neutrons compared to 300 kV x rays for the induction of the bone marrow syndrome and the intestinal syndrome in mice. A major uncertainty in the interpretation of these studies arise from the fact that the RBE-LET relations may well differ for different types of cells. In order to evaluate such differences the spleen colony technique has been used to study the proliferation of haemopoietic cells in mice after irradiations with 15 MeV neutrons and 300 kV x rays. RBE values for the survival of colony forming units for both in vivo and in vitro irradiations have been compared with the RBE for the bone marrow syndrome. The implication of these results for the occurrence of the two radiation syndromes after neutron- and x-irradiation is discussed. (auth)

44591 MORPHOLOGIC CHANGES IN RAT THYROID FOLLOWING FRACTIONATED LOCAL X IRRADIATION. Kovacs, Laszlo; Scabo, Zsuzsa (Medizinisch-Radiologische Forschungsgruppe, Budapest. Staatliche Institut fuer Hygiene, Budapest). Strahlentherapie; 139: 487-95(Apr 1970). (In German).

The effects of fractionated and localized roentgen irradiation on the thyroid glands in albino rats were studied with chemical and autoradiographic methods. Ten days after irradiation, the lesions were not very pronounced, but much more after 50 days. After 100 days, even regenerative modifications were observed. These were preponderant after 150 days, the cellular neoformation and irregularity of the acini were remarkable. (auth)

44592 METABOLISM OF ISOLATED PERFUSED RAT LIVER FOLLOWING IRRADIATION IN VITRO. I. LACTATE, PYRUVATE, GLUCOSE, POTASSIUM, SODIUM, CHLORIDE AS WELL AS THE ACTIVITY OF GOT AND GPT IN THE PERFUSION PLASMA. Staehler, Fritz; Sinn, Ingolf (Univ., Hamburg). Strahlentherapie; 139: 496-505(Apr 1970). (In German).

Isolated and perfused rat liver was irradiated with 1000 or 5000 rd of 200 kV x-rays. After a transient increase, a decrease of the pyruvate and lactate in the perfused plasma was observed. The lactate/pyruvate ratio was also depressed; glucose content in the plasma was reduced. The glycogen content of the liver was lowered in two phases and then increased. There was also an increase in the passage of enzymes in the perfused plasma. The decrease of sodium and chloride in the plasma without changes in the potassium content was caused by a transient cellular edema. These observations showed that certain modifications that are also noted in vivo were due to a direct effect on the metabolism of the liver. (auth)

44593 DEVELOPMENT OF SHOCK FROM IRRADIATION HAZARDS. Van Dorp, N.; Szirmai, E. Nucl. Hematol. (Publ. Nucl. Energy); 11: 48-50(Mar-Apr 1970).

Literature concerned with the shock syndrome is reviewed briefly from 1935 to 1967. The syndrome developing after a lethal high dose of whole-body radiation corresponds to a description of traumatic and hemorrhagic shock. Work with rabbits, chickens, dogs, and rats is mentioned. (UK)

44594 INFLUENCE OF WAVELENGTH ON BIOLOGICAL EFFECTS. RADIATION ACTION SITES IN THE SKIN. Jolles, B.; Harrison, R. G. (Northampton General Hospital, Eng.). Brit. J. Radiol.; 43: 501-2(Jul 1970).

It was found that whereas marked increase in the permeability of skin vessels occurs after irradiation with x rays generated in the range 50 kV (HVT = 0.5 mmAl) to 230 kV (HVT = 1.85 mmCu), no vascular permeability changes take place when animals are exposed to similar doses of γ rays from a ^{60}Co source. With x rays at 2 MeV, (HVT = 12.5 mmCu) from a Van de Graaff generator, a lower increase of permeability was observed than in the case of the lower voltage radiation. Parrallel findings were observed in the case of erythemas produced by x irradiation and ^{60}Co beams. The relative effect of radiation appears to be a function not only of LET, but of inhomogeneous depth dose distribution, and its variations due to the organisation of the skin as a tissue. (UK)

44595 ^{90}Sr: EFFECTS OF CHRONIC INGESTION ON FARROWING PERFORMANCE OF MINIATURE SWINE. Clarke, William J.; Palmer, Ray F.; Howard, Edwin B.; Hackett, Patricia L.; Thomas, John M. (Battelle-Northwest, Richland, Wash.). Science, 169: 598-600(7 Aug 1970).

In experiments involving the ingestion of strontium-90 by nearly 800 female miniature swine and extending over three generations, no significant differences in litter size, percentage of stillborn, or birth weight were observed between controls and animals ingesting up to 625 microcuries of strontium-90 per day. At 625 microcuries per day, these animals were ingesting more than a million times the peak value of strontium-90 ever reported in the American diet. Animals on 3100 microcuries per day did not survive the gestation period. From these studies, it is evident that feeding levels of strontium-90 high enough to affect fetal or neonatal mortality in this species will not permit maternal survival long enough for the bearing of young. (auth)

44596 MECHANISM OF NEURO-HUMORAL REGULATION IN INCORPORATED IRRADIATION WITH RELATIVELY SMALL DOSES OF IONIZING RADIATION. Mil'ko, V. I. (Kiev Medical Inst.). Vrach. Delo; 1: 2-6(Jan 1969). (In Russian).

Experiments on rats and rabbits as well as studies in man indicate that single and repeated administrations of radioisotopes (^{131}I and ^{32}P) in relatively small doses (0.3 to 15 mmc/kg) result in changes of the threshold of effects of the vagus nerve on the heart and motor nerve on the skeletal muscle, cholinesterase activity and catecholamine content in the heart, liver and brain, changes of the adrenal medulla and cortex, thyroid gland and pituitary. It is supposed that the changes of neurohumoral regulation are to a large extent connected with the mechanisms of action of the incorporaied irradiation. (auth)

44597 SKIN RESPONSE TO A POINT SOURCE OF FISSIONED ^{235}U-CARBIDE. Dean, P. N.; Langham, J.; Holland, L. M. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 19: 3-7 (Jul 1970).

Development of nuclear rocket propulsion engines poses a potential skin exposure problem. Presently, fuel elements in these engines are composed of about 10^{12} $^{235}UC_2$ microspheres 100 to 200 μ in diameter. Fuel element pieces (a few microns to full size particles) may be ejected from the engine during operation in or reentry into the atmosphere. Such particles may have undergone 10^8 to 10^{13} fissions and have surface dose rates of 10^3 to 10^6 rads/hr. This paper presents results of several experiments performed to evaluate immediate or short-term skin response to fissioned $^{235}UC_2$ particles. Particles delivering integrated surface doses of 6,600 to 2,500,000 rads with exposure times of 3 to 6 hr were placed on the back of monkeys, and the progress of the lesions was observed clinically and histologically. Skin lesions produced by integrated surface doses of 97,000 to 215,000 rads were observed on one human subject. Responses ranging from mild erythema to ulceration of monkey skin and from mild erythema to questionable or slight dry desquamation of human skin have been observed. (auth) (UK)

44598 EFFECT OF X-IRRADIATION ON THE CANINE HEART. AN EXPERIMENTAL STUDY. El-Naggar, A. M.; Badran, A.; Abdallah, A.; Mahmoud, K. A. (Atomic Energy Establishment, Cairo, Inst. of Research for Tropical Medicine, Cairo). Isotope Radiat. Res.; 2: 17-25(Jun 1969).

The effect of deep x irradiation at dose ranges of 1000 to 8000 R on the canine heart was studied with reference to electrocardiographic changes, serum transaminase levels, and cardiac measurements. T-wave changes were most conspicuous starting at doses of 2000 R. Doses of 5000 R and above were found to be lethal. No changes were observed in enzyme studies or in the cardiac size. The significance of these findings is discussed in the light of existing relevant knowledge. (auth)

44599 CHANGES IN THE BACKGROUND ELECTROCORTICOGRAM AND EVOKED RESPONSES OF THE RABBIT CEREBRAL CORTEX DURING PHOTOSTIMULATION IN THE COURSE OF IRRADIATION. Nadareishvili, K. Sh.; Bakradze, O. S. Tr. Inst. Fiziol., Akad. Nauk Gruz. SSR; 15: 321-32(1968). (In Russian).

Dynamics of changes of ECoG and evoked responses (ER) in the primary and secondary visual somatosensory, motor and limbic cortex of rabbit's brain were studied in chronic cases. Total and local irradiation of the head and body was used. At the beginning of irradiation when a diffuse desynchronization of ECoG develops, the amplitude of ERs is augmented and in spite of the continuous exposure and the recovery of the initial background ECoG, there is a further rise in ERs up to the dose of 8 to 10 krads. Over this dose ER amplitude is diminished, while at 12 to 14 krads no responses are in evidence. In case of body irradiation with an intact brain, ERs may be recorded up to the dose of 30 to 40 krads. The most sensitive to irradiation is the secondary component of ER, that disappears earlier and at smaller doses of about 6 to 7 krads. In the case of prolonged irradiation, as well as in the case of its cessation after ER has disappeared, ERs as a rule do not recover throughout the post-irradiation period to the death of the animals. (auth)

44600 DECREASE OF THE CALCIUM CONTENT OF CRYSTALLINE LENSES INJURED BY LASER RADIATION. Simakov, Yu. G.; Poluektova, M. L.; Popov, V. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 188: 1387-9(21 Oct 1969). (In Russian).

The action of neodymium laser beams with a wavelength of 10,600 Å on the crystalline lens of the eyes of Rana temporaria resulted in the development of circumferential cataracts which, after 7 days, became total. Both eyes of 15 frogs were irradiated with 0.18-joule, 3×10^{-8} sec pulses, 10 with 0.12-joule and 6 with 0.04-joule. The first two beams caused cataracts in about 50% of the eyes; the eyes of animals exposed to 0.04-joule laser pulses, although injured, did not become clouded. The bound calcium content of the irradiated and normal eyes was determined by histochemical reaction of the sections with alafarine red. The results indicated that in contrast to old-age cataracts, the laser-induced cataracts caused a decrease in the calcium content of the crystalline lens as the cloudiness becomes more marked. In this respect, the laser and galactose-generated cataracts are similar. There are indications, however, that during the earlier stages there are jumps in the calcium binding. The removal of calcium is probably a secondary effect of the disturbance of metabolism in the injured parts. (TTT)

44601 SURVIVAL OF LABELLED AND NON-LABELLED PLATELETS IN THE LETHALLY IRRADIATED DOG: AN EVALUATION OF THE ^{51}Cr METHOD. Kummer, H.; von Muehlenen, A.; Laissue, J. (Univ., Bern). Helv. Med. Acta; 35: 226-35(1969-70).

An experimental model for testing the ^{51}Cr labeling method as a tool for evaluation of true platelet life span is presented and critically evaluated. It consists in a comparison of ^{51}Cr survival data with the numerical decline of circulating platelets in lethally irradiated animals with total arrest of thrombocyte production. In all experiments the specific activity of the circulating platelets remained stable throughout the survival study, indicating that the ^{51}Cr survival curve measures accurately the true survival of the unlabeled platelet population. In addition data on platelet recovery and survival in normal and lethally irradiated dogs are presented. The results of the two groups do not differ significantly and favor the concept that, neither the effects of lethal irradiation nor a rapidly progressing numerical decline of circulating platelets is necessarily associated with a shortening of platelet survival. (auth)

44602 COMPARATIVE SENSITIVITY OF THE NUCLEAR AND MITOCHONDRIAL DNA SYNTHESES TO X-IRRADIATION AND TO THE ADMINISTRATION OF A SULFHYDRYL RADIOPROTECTOR (AET) IN NORMAL AND REGENERATING RAT LIVER. Baugnet-Mahieu, L. (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.); Goutier, R.; Baes, C. Biophysik; 6: 357-66(1970).

Incorporation of thymidine into nuclear and mitochondrial DNA was measured in the livers of normal rats and of rats killed 17 h or 24 h after partial hepatectomy. When total-body x irradiation (500 of 1,500 R) is given at increasing intervals (up to 30 h) before sacrifice, a progressive decrease followed by a plateau of low level of incorporation is observed in the nuclear DNA (N-DNA) whereas the synthesis of mitochondrial DNA (M-DNA) first decreases until a minimal value is reached after 4 h in normal liver and 12 h in regenerating liver, then recovers at an exponential rate, quite independently of the nuclear DNA synthesis. The results suggest that irradiation can interfere with the enzymatic processes of both M-DNA and N-DNA syntheses, but that the persistence of the inhibition of N-DNA synthesis must be ascribed to a temporary block in the cell cycle. The SH-protector AET injected into non-irradiated rats exerts a very small inhibitory effect on normal liver N-DNA and M-DNA syntheses. In regenerating liver, both syntheses are affected rather similarly suggesting a common mechanism of inhibition through impairment of some step in the synthetic process. (auth)

44603 EFFECTS OF LASERS ON THE EYE. Campbell, Charles J.; Rittler, M. Catherine (Presbyterian Hospital, New York, Columbia Univ., New York). Ann. N. Y. Acad. Sci.; 168: 627-33(Feb 1970).

Several laser devices were experimentally employed on the eye of the chinchilla rabbit, and significant clinical achievements were made with a pulsed ruby device. The experimental lesions demonstrate that the eye is unusually sensitive to many laser effects. This results in part from the high absorption of transparent structures at the longer wavelengths and from the concentrating effect of the optical system of the eye in the visible and adjacent regions of the spectrum. The clinical studies were particularly rewarding since the ruby laser has already achieved a definite role in the management of ophthalmological problems. (auth)

44604 X-IRRADIATION OF PREGNANT MONGOLIAN GERBILS. McGaughey, R. W.; Chang, M. C. (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Anat. Rec.; 167: 37-53(May 1970).

Female Mongolian gerbils were x-irradiated at various doses from 200R to 1200R on day 2 (fertilized eggs at 2-cell stage) or day 9 (embryos at the early primitive streak stage) after mating and examined on day 18. No significant differences in numbers of corpora lutea were observed between controls and females irradiated at 200 to 800R on day 2 or day 9, although irradiation at 1200R on day 2 caused regression of all corpora lutea. Preimplantation loss as determined by the proportion of eggs that failed to implant in the pregnant females, was significantly increased only in the females irradiated at 1200R on day 2 (100% loss) as compared with control animals. The mean numbers of fetuses were significantly reduced in the females irradiated on day 2 at 400R (300 ± 0.71) and at 800R (1.2 ± 0.37), or on day 9 at 400R (3.0 ± 1.14) or at 800R (0) as compared with controls (5.4 ± 0.51) The embryonic loss after but not before implantation was significantly increased in all irradiated animals except those irradiated at 200R on day 9. When mated females irradiated at 400R or 800R on day 2 were examined on day 12, 15, or 16 of pregnancy, the mean diameter of implantation sites was significantly smaller in the females irradiated at 800R on day 2 (5.4 ± 0.53 mm) than those

in the control females (9.3 ± 0.17 mm). No gross abnormalities of fetuses were observed in the control animals, only two abnormal out of 21 fetuses were found in females irradiated on day 2, but various abnormalities, such as retarded development, cleft palate, spina bifida, acephaly, or amorphous fetuses were observed in 20 out of 45 fetuses from females irradiated at 200 to 400R on day 9. Histological examination of ovaries revealed that all pregnant females had fully developed corpora lutea while the ovaries of females without implantation sites following irradiation contained regressing corpora lutea, and in some cases newly formed corpora lutea. The number and morphology of chromosomes of embryos from females irradiated at 400R or 800R were examined, but no differences were found as compared with embryos of control animals. It appears that whereas x irradiation of the 2-cell gerbil eggs increased the mortality of implanted embryos, irradiation of the early primitive streak stage caused embryonic death as well as developmental abnormalities. Chromosomal abnormalities of fetuses, however, were not observed. (auth)

44605 BIOLOGICAL EFFECT OF RADIOPHOSPHORUS, ^{32}P IN THE MOUSE. Holmberg, E. A. D.; Dosne Pasqualini, C.; Rabasa, S. L. (Instituto de Investigaciones Hematologicas, Buenos Aires). Medicina (Buenos Aires), Suppl.; 28: No. 1, 152-60(Dec 1968). (In Spanish).

Phosphorus-32 was administered to adult mice in ten doses that varied from 0.65 to 120 μc. The overall incidence of leukemia was 27% in 351 mice as compared with 15% in controls. When the experimental animals were separated according to sex, it was found that the incidence of leukemia was 37% in females and 16% in males. When ^{32}P was administered to pregnant females the incidence of leukemia in the offspring was found to be 46% in females. When leukemic organs were transplanted to newborn and one-month old mice, the incidence of leukemia was found to be 41 and 53% respectively. Phosphorus-32 produced sterility in female mice only, and administration of ^{32}P to pregnant females induced sterility in the offspring. Lesions induced by ^{32}P in the gonads are described. It was found that ^{32}P produced a primary lesion in the hypothalamic-hypophyseal axis that resulted in a deficient production of gonadotrophins. (H.L.W.)

44606 HISTOLOGICAL STUDY OF THE GONADS OF MICE TREATED WITH ^{32}P DURING FETAL LIFE. Penchansky, L.; Gonzalez Cueto, D. (Instituto de Investigaciones Hematologicas, Buenos Aires). Medicine (Buenos Aires), Suppl.; 28: No. 1, 161-4(Dec 1968). (In Spanish).

Radioactive phosphorus, ^{32}P, administered during fetal life, causes sterility in both male and female mice. The ovary presents follicular aplasia and luteinization of the stroma. The testis shows absence of spermatogenesis and hyperplasia of the Leydig cells. These gonadal alterations have been studied histologically, from birth to adulthood. ^{32}P, in a dose of 60 μCi, was administered intraperitoneally to pregnant mice of the BALB strain, between the 11th and 15th day of gestation. Siblings were sacrificed every 5 days starting 24 hours after birth up to 60 days of age. Histological studies were carried out on the gonads, adrenals, submaxillary glands and vagina in the females. (auth)

44607 BIOCHEMICAL CHANGES IN BLOOD INDUCED BY IN VITRO X IRRADIATION. Arky, I.; Szasz, I.; Gardos, G. (Central Inst. of Hematology and Blood Transfusion, Budapest). Haematologia (Budapest); 3: No. 1, 51-8(1969).

X irradiation (1000 to 25000 R) damages both the erythrocyte membrane and intracellular compounds, increases membrane permeability, activates hexokinase and G6PD, and reduces the ATP content and the survival time of erythrocytes. An in vitro procedure for the screening of radioprotective agents is described. (Excerpta Med.)

44608 HISTOCHEMICAL AND HISTOAUTORADIOGRAPHICAL STUDY OF THE ^{125}I IRRADIATED RAT THYROID. Konecny, Milan (Purkyne Univ., Brno). Atomkernenergie; 16: 83-8 (1970).

The radiation effect of ^{125}I on rat thyroid was studied histochemically and by means of histoautoradiography. Also cytochemical methods, techniques visualizing the lysosomes, mitochondria and periacinar vascular channels were used. Alterations were found only in lysosomal enzymes, whereas no changes were observed in the enzyme activities of both the mitochondria and periacinar vascular channels. Histoautoradiographs showed a parallelism to the values of the nuclear scintillation counting technique. The rapid decay of the ^{125}I activity indicating a functional impairment of the thyroid precedes the histological and cytochemical changes. (auth)

Man

Refer also to abstracts 44463, 44525, 44528, 44534, 44572, 44581, and 44596.

44609 (AD-685840) A STUDY OF EARLY RADIATION-INDUCED BIOLOGICAL CHANGES AS INDICATORS OF RADIATION INJURY. Final Report. (Federation of American Societies for Experimental Biology, Bethesda, Md. Life Sciences Research Offices). Mar 1969. 205p. CFSTI.

Current research on the biological effects of radiation is studied to explore the possibility of developing improved treatment measures. Prompt diagnosis of the radioinduced injury is important in prognosis and the military use of these clinical judgements will determine the immediate future role of the soldier. The scope of the study included: the use of physical dosimetry; early clinical manifestations of radioinduced emesis; radioinduced cytological changes in the testes; urinary constituents as predictors of radiation injury; hematologic changes; serum iron levels as indicators of hematopoietic dysfunction or injury; etiocholanolone in estimating bone marrow granulocyte reserves; total protein-bound neutral hexoses in the plasma as related to radiosensitivity; effects of radiation on detoxification enzymes, drug metabolism, and biochemical changes; and chromosome aberrations as indices of radiation injury. (auth) (USGRDR)

44610 INJURY TO THE HEART FOLLOWING TUMOR IRRADIATION IN THE THORAX REGION. Brand, E.; Klemm, J. (Medizinische Univ., Munich). Strahlentherapie; 139: 410-17 (Apr 1970). (In German).

Thirty-four patients irradiated for tumor therapy were observed, on the average of 12 months, for radiogenic lesions of the heart. 60% showed alterations, provoked exclusively or to a greater part, by radiotherapy. Manifestations in the patients were as follows: roentgenologic 90%, electrocardiographic 73.4%, and only 52.6% were clinical lesions. The roentgenologic alterations were taken as a most subtile item for a lesion caused by irradiation, whereas ECG indicated more serious alterations, and clinical research merely proved heaviest changes. Manifestations of the disturbances occurred with equal frequency immediately after irradiation or up to 6 months. 75% of the patients affected presented minor alterations already before irradiation, and some patients demonstrated lesions not before a longer period of latency; these two facts led to the conclusion that several factors were the cause for the observed lesions. Followup proved that a latent lesion may be at hand even in those patients whose diagnoses were not pathological immediately after therapy. This latent lesion became evident only after additional strains. The most frequent results were: increase of cardiac volume, especially of the left auricle, as far as roentgenologic alterations were concerned, and sinus tachycardia among the ECG results. Lesions of the pericardium, as a consequence of irradiation effects, were found very rarely. The lesioned organs, such as auricles, trachea oesophagus, and lungs, were part of deeper layers. Prophylactic digitalization seemed to be promising. (auth)

44611 FINE-TISSUE STUDIES ON THE HUMAN EYE SUBSEQUENT TO TELETHERAPY WITH GAMMA RADIATION. Claus, H. G.; Cullmann, B. (Johannes Gutenberg Univ., Mainz). Strahlentherapie; 139: 418-25(Apr 1970). (In German).

The results of cellular investigations of several enucleated bulbs are presented and discussed as a supplement to a preceding work about clinical eye diagnoses after high-dosage telecobalt irradiation. All ocular tissues, except those of the sclera, showed significant destructive alterations, among which the alteration of the vascular system was the most striking one. (auth)

44612 HISTORY OF THE EXPOSURE OF MINERS TO RADON. Behounek, F. (Nuclear Research Inst., Prague). Health Phys.; 19: 56-7(Jul 1970).

Following the data examined by Holaday (NSA 23: 26915) further figures are given of ^{222}Rn content in the St. Joachimsthal mines. Airborne ^{222}Rn was measured between 1924 and 1938 by means of an ionisation chamber and compared with that extracted from a solution of standard radium carbonate. The content of ^{222}Rn and ^{226}Ra in mine water and rock was also determined. Typical results are given. The passage of ^{222}Rn from the rock into the galleries was studied with a view of choosing an efficient ventilation system. After a pressure ventilation system was established in 1930 the airborne radon content fell to 350 pCi/l from the previous figure of 320 to 8,950 pCi/l (M.P.L. 30 pCi/l). A complete investigation of the "miner disease of St. Joachimsthal" was carried out at the same time. The main features of this work were: the bronchoscopy of the working and retired miners and of personnel from other radioactive localities, the autopsy of the diseased people with sampling of their lungs and spines and the physical measurements of the ashed samples. In the latter the gross alpha activity and the ^{226}Ra content were determined. The autopsies showed that from 1928 to 1938 45.4% of the 63 persons examined died from lung cancer and 30.7% from phthisis. Due to lack of

cooperation very few autopsies could be performed and thus the results are inconclusive. (UK)

44613 SYMPTOMS OF NERVOUS SYSTEM LESIONS IN ACUTE LOCAL RADIATION INJURIES. Panov, A. G.; Ulitovskii, D. A.; Mikhailenko, A. A. Zh. Nevropatol. Psikhiat.; 69: 975-8 (1969). (In Russian).

A case report is presented of a patient, 28 years of age, who received local irradiation of the left iliac area and several other points from ^{60}Co with an activity of 400 mc. The dosage at the point of application amounted to 6550 rad. The average dose for the organism amounts to 4, 6 rad. As a result of irradiation a local necrosis of the tissues developed, an obturation of the sigma and multiple lesions of the nerves in the left iliac area. This case attracts attention to the possibility of a different correlation between the general and local neurological disturbances in irradiation injury, to the symptoms of irradiational multineuritis, its mechanism of development and questions arising in relation to this problem. (auth)

44614 RADIOLOGICAL STUDY ON THOROTRAST LIVER WITH AN ADDITIONAL REPORT ON TWO CASES OF LIVER CANCER CAUSED BY THOROTRAST. Kido, Choichiro; Kaneko, Masao (Aichi Prefectural Cancer Center, Nagoya, Japan). Jap. J. Clin. Radiol.; 14: 673-80(Aug 1969). (In Japanese).

So-called Thorotrast liver, that is Thorotrast deposited on the reticuloendothelial system, was radiologically studied a long time after angiography. The following results were obtained: according to the abdominal scout roentgenograms of 25 cases whose amount of Thorotrast injection was known, no finding was obtained neither was the irregular deposit on lymph nodes in the upper abdomen seen, when 5 ml of Thorotrast was injected. On injection of 9 ml, fine granular shadows were seen in lymph nodes of the upper abdomen and in the spleen. When 13 to 15 ml was injected, diffused granular shadows were observed in the liver, and the silhouettes of spleen and lymph nodes became darker. On injection of more than 20 ml, the liver was always visualized and in it coarse trabecular and fine granular shadows were seen. In most cases, the spleen was contracted. When tomograms or axial transverse tomograms were taken after pneumoretroperitoneum, the change in each segment of liver or the connection between liver and other adjacent organs was shown in detail. In selective hepatic arteriogram, the narrowing, sclerotic change, and tortuosity of peripheral branches of the hepatic artery were visualized. Thorotrast livers showed a similar pattern in hepatoscintigram to liver cirrhosis. Two cases of liver cancer that developed from Thorotrast liver died 19 years and 27 years after the injection of Thorotrast. Their autopsies revealed that they were an intrahepatic cholangioma and a primary hepatic adenocarcinoma. In both cases, many metastases were observed in the thoracic and abdominal cavities. (NSA of Japan)

44615 CHANGES IN EXCHANGEABLE BODY SODIUM (Na_e) AND POTASSIUM (K_e) CONTENT IN PATIENTS WITH NEOPLASTIC DISEASE TREATED WITH IRRADIATION. Olson, Marvin; Hansen, Henning; Smitten, Lizabeth; Tyson, Ian (Univ. of Wisconsin, Madison). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 823-32(Aug 1970).

Marked changes in exchangeable sodium (Na_e) and potassium (K_e) levels were observed in nine patients treated for cancer with ^{60}Co γ radiation. There was generally an increase in the Na_e/K_e ratio caused by an increase in exchangeable sodium and a decrease in exchangeable potassium. These changes were more severe with larger integral doses of radiation. Other contributing factors may be trauma of surgical procedures, variation in food intake, and concomitant administration of cytotoxic drugs. (auth)

44616 A NOTE ON THE NUCLEAR PROCESSES STIMULATED BY BIOLOGICAL MATERIALS. Wszolek, B.; Kukiel, E.; Konarski, J. (Technical Univ., Poznan, Poland). Acta Phys. Pol; 36: 1115-17(Dec 1969).

Some trial interpretations of observed nuclear phenomena in biological material are presented. (auth)

44617 ORIGIN OF UNDIFFERENTIATED NEOPLASM FROM VERRUCOUS EPIDERMAL CARCINOMA OF ORAL CAVITY FOLLOWING IRRADIATION. Proffitt, S. D.; Spooner, T. R.; Kosef, J. C. (Veterans Administration Hospital, Palo Alto, Calif. Stanford Univ., Calif.). Cancer; 26: 389-93(Aug 1970).

Apparent anaplastic transformation of an x-irradiated verrucous carcinoma of the oral cavity is described in detail, including ultrastructural observations. The anaplastic lesion had definite epidermoid differentiation in the form of tonofibrils and tonofilaments, demonstrable only with electron microscopy. It and the well-differentiated one coexisted discretely and metastasized independently. It is proposed that the former arose as a new carcinoma from the cells of the latter, rather than through a transformative dedifferentiation. (auth)

44618 STUDIES ON RADIORESISTANCE WITH HeLa CELLS. ESTABLISHMENT OF A RADIORESISTANT LINE. Muta, Nobuyoshi; Koiwai, Soichiro (Sapporo Medical Coll., Japan). Radiat. Res.; 43: 332-40(Aug 1970).

HeLa cells were successively irradiated with 1 kR of x rays. After receiving 3, 5, and 8 kR, the HeLa cells showed progressively increasing radioresistance. To investigate the mechanism of acquiring radioresistance, subcultures from a single HeLa clone were irradiated with 1 kR of x rays. The results suggest that in a homogeneous cell strain it is difficult to acquire radioresistance; mutation and selection must act together. The generation time of HeLa cells increased slightly with increasing radioresistance. It was found, however, that the decreased x-ray damage in the resistant strain was due to some factor other than merely the prolongation of the generation time. (auth)

44619 A CASE OF LEUKEMIA PRESUMABLEY INDUCED BY RADIATION. Oftedal, P. (Norske Radiumhospital, Oslo). Tidsskr. Norske Laegforen.; 89: 732-5(15 May 1969). (In Norwegian).

While assisting in x-ray control of welded joints in 1958, a man was accidentally exposed to a 10 rem bone marrow dose. In May 1965 he was recognized as suffering from CGL, of which he later died. A computation, based on Baye's law, of the probability of the disease having been induced by irradiation, which is compared with the probability of a spontaneous origin of the disease, as supplied by Norwegian statistics of CGL is given. The ratio of the probabilities is about 3 : 1. (Leukemia Abstr.)

44620 RADIUM SENSITIVITY AND THE RESULTS OF OPERATION FOR CANCER OF THE CERVIX. Kralova, A.; Ulrych, J. Zentralbl. Gynaekol.; 91: 406-10(1969). (In German).

The effect of preoperative preliminary irradiation of cervical carcinoma was studied in 100 women, who were subsequently submitted to operation. It was concluded that devitalization of the cancer tissue occurred in only 55% of the cases, whereas 37% showed no radiation changes of cancer tissue. There was residual atypical epithelium in 8%. The 5-year cure rate controlled in 43 women was significantly lower (42.1%) in women with cancers refractory to radiation compared to women with radiosensitive cancers, where it amounted to 90.5%, or to cases with persistent atypical epithelium (66%). (Excerpta Med.)

Radiation Effects on Plants

Refer also to abstracts 44385–44387, 44417, 44439, 44459, 44460, 44465, 44537, 44616, 44634, and 44644.

44621 (EUR-4452, pp 801-12) ELECTRON DEGRADATION AND BIOLOGICAL EFFECTS. Markus, B. (Goettingen Univ. (West Germany). Hautklinik).

After a short survey of the theoretical state, practical ways of experimentally investigating the effect of the energy spectrum of fast electrons on biological reactions are described. Proof depends on suitable dosimetry and the choice of biological subjects and reactions. Criteria that are relatively independent of the dose and show qualitative differences in effect between various types of radiations proved especially suitable. In the experiments carried out with 14.2 MeV electrons (betatron), the different energy spectra were obtained by varying the irradiation depth (5 and 53 mm perspex). The radiation effects observed were chromosomal aberrations in the tips of roots of Allium cepa (the onion): the relative frequency following irradiation displays a variation with the electron spectrum. It was shown, by labelling with ^{3}H-thymidine, that there is differing sensitivity to different electron spectra. In the various dose ranges the lengthwise growth of the primary leaves of Hordeum (barley) displayed a stimulation effect differing significantly depending on the electron spectrum. The results are discussed. (auth)

44622 (ORO-3400-5-a) CHARACTERISTICS OF XYLEM TISSUES EXPOSED TO IONIZING RADIATION. Final Report. Hamilton, John R. (West Virginia Univ., Morgantown). [1970]. Contract AT(40-1)-3400. 8p. Dep. CFSTI.

In summary, this study of irradiation effects in red oak and yellow-poplar seedlings permitted the following conclusions: growth and secondary xylem development in red oak and yellow-poplar seedlings were modified by exposure to gamma radiation. Initiation of bud activity was delayed by irradiation to a greater degree in red oak seedlings than in yellow-poplar seedlings subsequent survival, however, was less in yellow-poplar seed-

lings than in the red oak seedlings. A reduction in xylem derivative production was associated with radiation intensity. In some instances where xylem derivatives were produced, differentiation was arrested and in others the shape of the differentiated cells was altered. The relative frequencies of the various kinds of cells was not altered although the percentage of latewood in red oak seedlings was reduced. The most pronounced anatomical effect of irradiation was a reduction in the radial dimensions of cells. This was particularly noticeable in the ray cells. The tangential dimensions were little affected. Irradiation at the lowest intensity studied (10.4r/hr) appeared to promote fiber wall thickening in red oak seedlings and initial bud activity in yellow-poplar seedlings. (auth)

44623 (UCB-34-P-147-X-3) A STUDY OF THE EFFECTS OF ENVIRONMENT, INDIVIDUAL NUTRIENT ELEMENTS, AND BETA EMITTERS ON THE FINE STRUCTURE OF PLANT CELLS. Final Progress Report, February 1, 1967–July 31, 1969. Day, Paul R. (California Univ., Berkeley. Dept. of Soils and Plant Nutrition). Contract AT(11-1)-34. 17p. Dep. CFSTI.

Separate abstracts were prepared for two of the three papers appearing in this report. The other paper, which discusses the hardness of Maraglas as affected by solvent–monomer interaction, was published previously in Stain Technology (July, 1969). (E.R.B.)

For abstracts of individual papers see: 44417 and 44489.

44624 INFLUENCE OF CHRONIC EFFECTS OF GAMMA RADIATION ON THE FORMATION OF SHORT ROOTS OF SCOTS PINE. Sobotka, A. Lesnictvi; 15: 429-36(1969). (In Czech).

The present study concerns the effect of interrupted chronic radiation on two-year-old Scots pine seedlings. The source of irradiation was ^{60}Co with activity 160 Ci. Radiation caused changes in the development of overground parts of seedlings and in a derived manner also in the root systems. Considerable changes were found in short roots; the diameter of their bark parenchyma was reduced up to one third of normal diameter and prolonged existence of root hairs occurred. Mycorrhizal roots indicated strongly reduced Hartig's net. The increased radiation rates increased the number of thinner dark-brown forms of short roots, where symbiotic fungi were altered by other species; these short roots indicated mortality of seedlings. Increasing radiation doses caused reduction of number of mycorrhizal roots. Lethal radiation doses of the above-mentioned type and regime for Scots pine seedlings amounted to 6500 to 6700 r. (auth)

44625 GENETIC EFFECTS OF GAMMA-IRRADIATION ON FUSARIUM MONILIFORME. Younis, S. E. A.; Ali, A. M. M. (Atomic Energy Establishment, Cairo. National Research Centre, Cairo). Isotope Radiat. Res.; 2: 65-70(Jun 1969).

The purpose of this investigation is an attempt to determine the effect of γ irradiation on the survivals and the induction of morphological and biochemical mutants in Fusarium moniliforme. This organism was found to be the most prevalent pathogen causing stalk-rot in many countries. Samples of conidia were exposed to 0, 1, 5, 10, 20, 40, 80, 100, 120, 140, 160, and 200 kR. The results showed that the lethal dose (50% survival) was reached at a dose of about 20 kR. Continuous reduction in survival resulted from increasing the dose. Twelve morphological mutants and only one biochemical mutant were obtained. The biochemical mutant, which was selected from the dose of 80 kR, showed that it is a methionine-requiring mutant. Further growth tests of this biochemical mutant on the methionine pathway precursors proved that it is a cystine-requiring mutant. (auth)

44626 EFFECTS OF SHORT- AND LONG-TERM IRRADIATION ON THE FLAVONOID COMPLEMENT OF THE TERMINAL BUDS OF PISUM SATIVUM VAR. ALASKA. Smith, Harry; Harper, David B. (Queen Mary Coll., London). Phytochemistry; 9: 477-85(Mar 1970).

Irradiation of etiolated seedlings leads to complex patterns of transitory changes in the concentration of the three major flavonol complexes in the terminal buds. Two categories of response are apparent, namely, a phytochrome-mediated rapid response of low magnitude, and a longer term response of greater magnitude dependent on continuous irradiation. None of the changes can be simply correlated with changes in growth rate. (auth)

44627 THE EFFECT OF IONIZING RADIATION ON THE REPRODUCTIVE CAPACITY OF FOREST TREES. Mergen, Francois (Yale Univ., New Haven); Stairs, G. R. Health Phys.; 19: 37-45(Jul 1970).

In a pine-oak forest exposed to chronic γ radiation the pine trees were more radiosensitive than the oaks. Low-level radiation accumulated over a period of years was lethal for many of the trees. Radiation damage was evident in pollen production, seed formation, and seedling behavior. Megasporogenesis evaluations indicated chromosome aberrations and delayed fertilization occurred at levels as low as 2.8 R/20-hr day. In general, seed production was compatible with vegetative survival despite the greater sensitivity of the meiotic cycle. Seeds stored in cones of pine trees that had been killed by radiation were able to germinate and produced apparently normal seedlings. The differential response between oaks and pines was strongly correlated with differences in nuclear volume; both species have a chromosome number of 2N = 24. Seed irradiation studies revealed that varying the physiological condition could change LD_{50} values by a factor of ten. Seed radiosensitivity was not greatly different between pines and oaks despite the greater sensitivity of the mature pine trees. Studies of male bud irradiation prior to pollen formation revealed this stage as one of the most radiosensitive. Pollen irradiation gave results generally similar to seed irradiation in terms of tolerance. The ability of pollen to fertilize the egg cell was destroyed at levels greater than 16 kR, although the pollen demonstrated some germination potential at levels up to 800 kR. (auth) (UK)

44628 INFLUENCE OF CHROMOSOME SIZE ON THE RADIOSENSITIVITY OF LINUM SPECIES. Bari, G.; Godward, M. B. E. (Queen Mary Coll., London). Can. J. Genet. Cytol.; 11: 799-802(Dec 1969).

Several factors were shown to influence the radiosensitivity of plants. Gustafsson (1944) reported that the seeds of oleiferous plants were highly resistant to x rays, and considered that the resistance was due to some physiological properties inside the cell and the nucleus, and suggested that the resistance was associated with the fat content. Sparrow and Evans (1961), and Evans and Sparrow (1961) have discussed the nuclear factors affecting radiosensitivity, and Konzak et al. (1961) have reviewed the physiological and morphological factors involved in the response of plants to radiation. Gustafsson (1944) studied the radiosensitivity of cultivated flax over a period of 2 yr by x-irradiating the seeds with doses ranging from 5 kR to 45 kR. But the variation between his results of 2 yr is so great that it seemed desirable to undertake fresh studies with a wider range of radiation dosage. In addition to the cultivated flax, Linum usitatissimum, 10 other species of the genus Linum were included in these studies. (auth) (Canada)

44629 DETECTION BY γ IRRADIATION OF THE INFLUENCE OF THE PERICLINE CHIMERA STRUCTURE OF A VARIETY OF CARNATION ON THE COLORING OF THE FLOWER. Pereau-Leroy, Pierre (CEA, Cadarache, France). Compt. Rend., Ser. D; 270: 810-12(9 Feb 1970). (In French)

The coloring of the flower of a pericline carnation chimera is not governed by the genetic characteristics of the pigmented layer alone. It seems to result from interaction of the genotypes of the two layers of the tunica. (France)

44630 EFFECT OF ^{60}Co GAMMA RADIATION ON THE SUNFLOWER. Savin, V. N.; Stepanenko, O. G. (Leningrad Research Inst. of Agricultural Physics). Sel'skokhoz. Biol.; 3: 921-2 (1968). (In Russian).

Irradiation of sunflower plants with 1 ev of ^{60}Co γ rays resulted in increased and improved growth of the plants due to the slower growth of the stems and the increased content of dry substances and sugars in the leaves. (R.V.J.)

44631 COMBINED EFFECTS OF SORBIC ACID AND GAMMA-RAYS ON THE SURVIVAL OF SACCHAROMYCES CEREVISIAE CONTAINING DIFFERENT AMOUNTS OF ERGOSTEROL. Duclos, J.; Dupuy, P. (Institut National de la Recherche Agronomique, Dijon, France). Ann. Technol. Agr.; 18: 351-8(1969). (In French).

Sorbic acid inhibits the growth of Saccharomyces cerevisiae at pH 3.4. The inhibition was not modified by sterols that had accumulated in the yeast cells or that had been added to the growth medium. The addition of ergosterol to the sorbic acid did not modify the release of amino acids from resting cells. Furthermore sorbic acid did not sensitize resting cells to γ irradiation. In this respect it differs from certain other food additives, such as SO_2 and diethylpyrocarbonate, that are sensitizers. The mode of action of sorbic acid in inhibiting growth is discussed with regard to the following two hypotheses. Sorbic acid may be an –SH poison. This hypothesis is unlikely because sorbic acid does not sensitize cells to the action of ionizing radiation. Sorbic acid may combine with the sterols of the membranes to affect permeability in a manner similar to the action of polyene antibiotics. This hypothesis is unlikely because sterols, accumulated in cells or added to the medium, did not affect inhibition by sorbic acid. (auth)

44632 PHYSIOLOGICAL RESEARCHES OF POLLEN. 17. ON THE RESISTANCE OF POLLEN TO RADIAL RAYS AND

CHEMICAL INHIBITORS. Iwanami, Yozo (Yokohama City Univ., Japan). J. Yokohama City Univ., Ser. C; No. 55, 1-31 (Aug 1968). (In Japanese).

The effects of radial rays and chemical inhibitors on pollen growth and pollen tube mitosis were investigated. For irradiation, γ rays were applied with ^{137}Cs 6,000 C at a dose rate 55 kR/hr. Chemical inhibitors such as antibiotics were added to the culture medium at a low temperature (30 to 40°C). 20 kinds of inhibitors were used. Inhibition of pollen growth and mitosis increased with increasing the dose of γ rays. Pollen has an extremely high radioresistance compared to the other cells of higher plants, for instance LD_{50}'s dose for germination of Lilium auratum pollen was 500 to 550 kR and 60 to 70 kR for pollen tube mitosis of Impatiens. Chemical reactions in a pollen grain such as starch formation and starch digestion had also a very high radioresistance. Pollen sown on a culture medium and that had absorbed water had a high radiosensitivity as compared to pollen before sowing. It is roughly 4 to 10 times as sensitive as pollen before water absorption. Pollen irradiated with a high dose of γ rays during the pollen tube growth produced various abnormal pollen tubes. The higher the dose of the γ rays, the more delayed was the time of pollen tube mitosis. The radiosensitivity of the generative nucleus varied widely according to the culture time, the sensitivity being extremely high 15 minutes after sowing (40 minutes before nuclear division). It can be assumed that some protein synthesis is taking place at this time. The effect of γ rays on seed production, using irradiated Portulaca pollen, was investigated. Total seeds produced were noticeably impaired at 1 kR and reduced to 60 and 98% of the controls produced at 40 and 80 kR respectively. Hank's solution strongly inhibited the pollen growth of Crinum asiaticum. Crinum pollen starts germination 26 minutes after sowing and pollen tube mitosis begins 7 hours after germination on SAP (sugar agar plate) with boric acid. The resistance of pollen growth and mitosis to chemical inhibitors (20 types) was varied. Respiration inhibitors like 2,4-Dinitrophenol strongly inhibited growth and mitosis and protein synthesis inhibitors such as Chloramphenycol affected pollen growth and pollen tube mitosis to a lesser degree, while DNA synthesis inhibitors such as Bromodeoxyuridine had little influence not only on pollen growth but on pollen tube mitosis. Colchicine strongly inhibited pollen tube mitosis and inhibited tube elongation to some extent in a fairly low concentration, however, an increase in concentration of Colchicine even when extremely high (2,000 ppM) did not affect pollen tube elongation. Actinomycin D affected pollen tube elongation to a lesser degree, but it strongly inhibited pollen tube mitosis. It can be surmized that the pollen nucleus has nothing to do with pollen germination. This does not mean that the nucleus is not a necessity for pollen but it means that before germination, the pollen grain already has received the message from the nucleus for pollen germination and pollen tube division. (NSA of Japan)

Radiation Effects on Microorganisms

Refer also to abstracts 44419, 44437, 44466, and 44650.

44633 (EUR-4452, pp 5-49) MECHANISMS OF LETHAL RADIATION DAMAGE TO CELLS. Alper, Tikvah (Medical Research Council, London (England). Experimental Radiopathology Research Unit).

The majority of models proposed for lethal radiation damage to cells are based on the assumption that primary events in DNA are the only ones of importance. However, from work done over the past decade it is inferred that nucleic acid is only one of two important sites of primary lesion, and that the non-nucleic acid target is the site at which radio-sensitization by oxygen occurs. Chemical protection, and sensitization in anoxic conditions, are also probably due to the effects of the agents concerned on the events following energy deposition in the non-nucleic acid site (type O damage). There is now inferential evidence that cell membranes are the site of type O damage, though there may be subsequent interaction with the lesions following energy deposition in DNA. Observations on the killing of bacteria by neutrons and by particles of defined LET led to the conclusion that increasing effectiveness, with increasing LET, is attributable to type O damage. It may be that the increase in effectiveness is caused by an increase in the probability of interaction of type O and type N events, rather than to an increase in the probability of damage to the membrane itself. (auth)

44634 (EUR-4452, pp 51-81) THE INTERPRETATION OF SURVIVAL CURVES IN RELATION TO RADIATION QUALITY AND CELLULAR REPAIR MECHANISMS. Neary, G. J. (Medical Research Council, Harwell (England). Radiobiological Research Unit).

The log-survival curves of bacteria and yeast have two obvious characteristics, the extent of the shoulder and the ultimate slope of the approximately linear later portion of the curve. Both characteristics are influenced by genetic factors which govern the operation of repair processes, and also by external factors of culture conditions. There is some evidence that the shoulder and slope are partly determined by different mechanisms of repair which are affected in different ways by the factor of radiation quality. In the analysis of the basic mechanisms of cell killing, it is necessary to consider the distinction between the primary molecular lesions, the lesions remaining after completion of the swift metionic reactions and the residual lesions after the intervention of post-irradiation repair and bypass mechanisms. The effects of radiation quality and modifying agents such as oxygen appear to be different for these three classes of lesion. These ideas are illustrated with some new experimental data on DNA strand breakage in vitro and on cell killing. Data on the comparative effects of heavy particles and x rays of low quantum energy show that the influence of radiation quality is complex and no simple index of quality is generally applicable. The importance of the chemical character of radiation-induced lesions in determining cellular responses shows that microdosimetry must extend to the consideration of events on the molecular scale and link up with radiation chemistry. (auth)

44635 RADIORESISTANCE AND SPORE ACTIVATION BY PERIODATE. Cultrera, Rolando; Casolari, Antonio; Campanini, Mirella. Ind. Conserve; 44: 204-8(Jul-Sep 1969). (In Italian).

The action exerted by periodate on dormant and ^{60}Co irradiated spores of Bacillus stearothermophilus leads to the assumption that spore inactivation by heat and radiation is due to oxidation phenomena that affect the molecules of tRNA-containing thionucleotides. (auth)

44636 RADIOSENSITIVITY OF HEAT-PRETREATED SPORES. Casolari, Antonio; Campanini, Mirella; Cicognani, Gabriele. Ind. Conserve; 44: 199-203(Jul-Sep 1969). (In Italian).

The resistance of spores of Bacillus stearothermophilus to uv and γ radiations proved to be highest after an activating heat treatment, lowest after a lethal heat treatment, and intermediate during biological dormancy. The correlation with the exposure levels of -SH groups in the different biological conditions of spores allows the molecular mechanism probably responsible for spore inactivation to be formulated. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 44385, 44386, 44408, 44431, 44435, 44473, and 44589.

44637 EFFECT OF GAMMA RADIATIONS ON THE RIPENING OF APRICOTS AFTER PICKING. Guelfat-Reich, Sylvia (Institut Volcani de Recherches Argronomiques, Bet-Dagan, Israel); Ben-Arie, Ruth; Kahan, R. S.; Eisenberg, E. Fruits (Paris; 24: 137-42(Mar 1969). (In French).

Gamma irradiation speeded up the ripening of Canino apricots kept at 20°C. The degree of softening is proportional to the radiation dose. In the nine days following picking, the irradiated fruits tended to become overripe and floury with internal browning of the pulp. Green fruits were less sensitive than pale green ones. Irradiation generally increased the respiratory activity of the fruit. The storage life of fruit at 0°C was not prolonged by irradiations of 25 and 200 krads, although this latter dosage reduced respiration of the fruit. The fruit showed excessive softening and undesirable internal browning. (auth)

44638 BIOLOGICAL STUDIES ON CULTURE AND ELIMINATION OF THE BEET FLY (PEGOMYIA BETAE CURTIS) BY MEANS OF THE SELF DESTRUCTION METHOD (STERILE MALE TECHNIQUE). PART 2. Malekghassemi, Behruz. Bayer. Landwirt. Jahrb.; 46: 958-80(1969). (In German).

Mature beet flies were fed on a mixture of honey, yeast, soy meal, and milk powder at an optimal temperature of 19 to 21°C. Large scale cultures of the fly with artificial nutrients could not be achieved; cut leaves of beets were always required. The flies were sterilized with ^{137}Cs γ radiation at 75 kR/min. Sterilization of both sexes without somatic injuries could be achieved with 2.5 kR at the pupa stage 1 to 5 days before emergence. As pest control, 2.2 kR was sufficient. In comparison with normal flies, irradiated males showed no loss of vitality. To be effective for pest control, the irradiated population must be considerably larger than the natural population. (H.B.G.)

44639 PRESERVATION OF FOOD BY RADIATION. Underdal, Bjarne. Nord. Veterinarmed.; 22: 75-84(1970). (In Norwegian).

The application of irradiation preservation of foods is discussed. The irradiation preservation technology has been developed mainly during the last two decades. As irradiation sources, ^{60}Co and electron accelerators are mostly used. According to dose level, irradiation of food can be divided into three main groups: sterilization, 4 to 6 MRad; pasteurization (radurization) 0.1 to 0.4 MRad; and sprout inhibiting irradiation, 0.01 to 0.1 MRad. At the higher dose level (4 to 6 MRad), many of the irradiated products develop unfavorable organoleptic changes (color, odor, and taste). At lower dose levels these organoleptic changes do not develop. These and the health aspects of irradiated food are discussed more in detail. Today it is possible, technologically, to irradiate food on a commercial scale. (auth) (Denmark)

44640 DETECTION OF IRRADIATION TREATMENT IN FOODS. Nawar, W. W.; Balboni, J. J. (Univ. of Massachusetts, Amherst). J. Ass. Offic. Anal. Chem.; 53: 726-9(Jul 1970).

The major radiolytic hydrocarbons resulting from specific cleavage of fatty acids can be used as indicators of irradiation in foods. Experiments with pork ground meat indicate that these compounds are present in samples irradiated at doses as low as 0.1 megarad but absent in unirradiated or heated samples. The major radiolytic hydrocarbons reflect the severity of the irradiation treatment, since their production increases linearly with dose and temperature of irradiation. The presence of moisture or air during the irradiation treatment does not significantly alter the radiolytic pattern. (auth)

44641 FIELD CAGE EVALUATION OF THE COMPETITIVENESS OF MALE GLOSSINA MORSITANS ORIENTALIS VANDERPLANK STERILIZED WITH TEPA OR GAMMA IRRADIATION. Dean, G. J. W. (University Coll. of Rhodesia, Salisbury); Dame, D. A.; Birkenmeyer, D. R. Bull. Entomol. Res.; 59: 339-44(Oct 1969).

Laboratory and field cage trials were made with male Glossina morsitans orientalis Vanderplank treated with TEPA or γ irradiation to assess the ability of the sterile males to compete with untreated males for normal females when the ratios of treated males to untreated males to untreated females ranged from 4:1:5 to 5:2:5. Irradiation of the pupal and adult stages with 8,000 and 15,000 rad to 8,000 and 12,000 rad, respectively, reduced reproduction by 87 to 100% (mean, 95%). Contact for 60 min on a glass surface coated with 10 mg tepa/ft^2 or exposure to 0.25 ml of 5% tepa in a wind tunnel usually produced complete sterility (mean, 99%) in 0- or 2-day-old male flies. Trials in the laboratory and in a small field cage (288 ft^2) with chemosterilised flies generally reduced reproduction to near the expected values. Similar results were obtained with male flies emerging from irradiated puparia, but males treated as adults produced somewhat smaller reductions than expected. Unreplicated competitive trials with chemosterilised and irradiated males in a large field cage (8,100 ft^2) produced considerably smaller reductions in reproduction than expected, suggesting that treated males released in nature might not compete for normal females as readily as untreated males. (auth)

44642 RADIOPRESERVATION OF MEAT PRODUCTS. II. OBSERVATIONS ON THE MICROBIOLOGIC AND ORGANOLEPTIC CHARACTERISTICS OF GROUND MEAT FOR HAMBURGER. Denti, E. (SORIN, Saluggia, Italy); Luboz, M. P.; Pesenti, G. Ind. Aliment. (Pinerolo, Italy); 9: 55-6(1970). (In Italian).

The results obtained using ionizing radiations for pasteurization of minced meat (type "hamburger"), packed under vacuum in plastic film are described. The samples were irradiated at low temperature, with 500 and 1000 Krad doses, then they were subjected to different conditions of storage. To achieve good results it is better to irradiate at -78°C, with doses of 500 Krad. (auth)

44643 USE OF IONIZING RADIATIONS TO PRESERVE SILAGE. Konoplev, E. G.; Lur'e, L. S.; Voropaev, Yu. V.; Srapenyants, R. A. Vestn. Sel'skokhoz. Nauki (Moscow); No. 6, 57-60(1969). (In Russian).

A green mass of pea-oat was irradiated with low doses (up to 25000 rad.) of γ rays. The silage obtained was of high nutritive value, losses of the dry matter in it being 22 to 33 per cent lower than in the control samples. (auth)

44644 EXTENSION OF STORAGE LIFE OF PAPAYAS GROWN IN PUERTO RICO BY GAMMA RADIATION TREATMENTS. Jiravatana, Vachira; Cuevas-Ruiz, Jose; Graham, Horace D. (Puerto Rico Nuclear Center, Mayaguez). Contract AT-(40-10-1833. J. Agr. Univ. Puerto Rico; 54: 314-19 (Apr 1970).

Shelf-life extension (measured as ripening delay) and the retention of nutrients in irradiated P. R. 965 papayas were investigated at constant storage temperature and relative humidity. The major findings were: The ripening process in irradiated papayas was delayed up to 7 days by the use of γ radiation treatments. The maximum delay in ripening was achieved by 25 to 50 Krads treatments, while the 100 Krad treatment showed a slight stimulation of ripening in storage. Some destruction of vitamin C (ascorbic acid) seemed to have been effected by the γ irradiation, although there were only slight differences between dose levels. The level of total carotenoids was not affected by γ radiation. During storage, there was a marked increase in these pigments as the papayas ripened. Gamma irradiation inhibited fungal proliferation on papaya fruit even at dosages of 25 Krad. There was no effect observed at the dosages studied on the skin of the fruit which developed its characteristic bright yellow color when ripe. (auth)

44645 EFFECT OF IRRADIATION OF VITAMIN E IN FOODS, ON TOCOPHEROL, AND ON TOCOPHEROL ACETATE. INFLUENCE OF DIFFERENT RADIATION CONDITIONS. Diehl, J. F. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch.; 142: 1-7 (1970). (In German).

Vitamin E destruction as a result of irradiation with electrons was compared in a number of foods. Losses were highest in products with high fat content. Losses of α-tocopherol in irradiated sunflower oil were not influenced by the presence of water (emulsified with Tween 80) but greatly influenced by the tocopherol concentration. Tocopherol was more radioresistant than tocopherol acetate. The protection provided by the exclusion of atmospheric oxygen during irradiation was small with tocopherol acetate, considerable with tocopherol. With tocopherol acetate dissolved in sunflower oil or in oil-water emulsion, the exclusion of atmospheric oxygen resulted in a 20% reduction of the loss caused by irradiation. Changes of dose rate in the ratio 1:100 had no effect on the loss caused by irradiation of α-tocopherol acetate. (auth)

44646 STRONGYLOIDIASIS OF THE RABBIT: TRIALS OF ACTIVE IMMUNIZATION WITH X-IRRADIATED FILARIFORM LARVAE OF STRONGYLOIDES PAPILLOSUS. Geyer, Egbert (Univ., Marburg, Ger.). Z. Parasitenk.; 33: 164-76(1969). (In German).

Results of vaccination with x-irradiated third stage Strongyloides papillosus larvae in rabbits are presented. Under the experimental conditions described significant resistance was observed in male rabbits (Chinchilla) following a previous massive (40,000 La III) single percutaneous exposure to irradiated larvae. The levels to which larvae were exposed (for attenuation) were 25, 50, 75 and 100 KR respectively. Resistance induced was sufficiently powerful to protect all of the vaccinated rabbits (age at vaccination: 9 to 10 weeks) from an otherwise lethal challenge (65. d.p.i.) with normal filariforme larvae (65,000 La III). The most significant reduction in challenge worm establishment was observed in rabbits vaccinated with 50 KR irradiated larvae. Control animals were severely affected (loss of body weight, diarrhoea, lack of appetite, apathy, and decreased erythrocyte values) until death occurred. Vaccination by a single small ($\frac{1}{4}$ LD) or moderate ($\frac{1}{2}$ LD) dose of normal larvae did not protect rabbits against challenge infection. X-irradiation of third stage larvae reduced infectivity varying with the amount of irradiation as measured by intestinal establishment of adult worms. Infection with x-irradiated larvae did not cause acute strongyloidiasis. (auth)

44647 RADIOPRESERVATION OF MEAT PRODUCTS. I. OBSERVATIONS ON THE MICROBIOLOGIC AND ORGANOLEPTIC CHARACTERISTICS OF COOKED OX TONGUE. Denti, E. (SORIN, Saluggia, Italy); Luboz, M. P.; Pesenti, G. Ind. Aliment. (Pinerolo, Italy); 9: 49-54(1970). (In Italian).

The results obtained from using ionizing radiations as a method of pasteurization for slices of cooked ox-tongue, pre-packed under vacuum in plastic film are described. The samples were irradiated with different doses, from 0.2 to 1 Mrad, and prepared in different ways. Afterwards microbiological and organoleptic examinations were made. It was possible to extend the preservation time without any change in the taste of the product with a dose of 0.6 Mrad. (auth)

44648 IRRADIATION OF EARLY INSTARS OF THE ANGOUMOIS GRAIN MOTH. Qureshi, Zafar A.; Wilbur, Donald A.; Mills, Robert B. (Kansas State Univ., Manhattan). J. Econ. Entomol.; 63: 1241-7(Aug 1970).

Effects of γ radiation from ^{60}Co on eggs and on 1st, 3rd, and last instars of Sitotroga cerealella (Olivier) were determined. Egg and larval sensitivity depended on age at treatment; the older the egg,

the less susceptible. No egg hatched in the 0- to 12- and the 0- to 24-hr age groups when irradiated at 6 kR and 10 kR, respectively. Hatching was observed at all doses in the 24- to 48- and 48- to 72-hr age groups. Larvae failed to develop at doses of 10, 14, and 18 kR. After doses of 2 and 6 kR and controls, larvae developed normally. Irradiation of 1st, 3rd, and last instars resulted in reduced numbers, in delayed and incomplete emergence, and in structural deformities such as twisted wings and fusion of tarsal and antennal segments. Females irradiated as 1st (18 to 24 hr and 4 days old), 3rd-, and last instars, then mated with normal unmated males or vice versa either laid infertile eggs or did not produce eggs at 14, 16, 17, and 20 kR, respectively. Emerged females following irradiation as last instars and mated with normal unmated males produced no eggs at 10 kR. (auth)

44649 MATING COMPETITIVENESS OF UNIRRADIATED AND IRRADIATED MEDITERRANEAN FRUIT FLIES. Holbrook, F. R.; Fujimoto, M. S. (Dept. of Agriculture, Honolulu, Hawaii). J. Econ. Entomol.; 63: 1175-6(Aug 1970).

In tests in Hawaii in 1968, the mating competitiveness of male Ceratitis capitata (Wiedemann), reared in the laboratory and treated with 10,000 rad γ irradiation as pupae 2 days before adult emergence, was reduced 50%. Females treated in the same way were not affected. Also, sterilized males initially responded to mating stimuli later in the normal daily mating cycle than normal males, and the time of the peak of mating activity of both treated sexes was delayed. (auth)

44650 SURVIVAL OF BACTERIOPHAGE IN SOIL STERILIZED WITH GAMMA IRRADIATION. Robinson, J. B.; Corke, C. T.; Jones, D. A. (Univ. of Guelph, Can.). Soil Sci. Soc. Amer., Proc.; 34: 703-4(Jul-Aug 1970).

Naturally occurring bacteriophage for Bacillus megaterium strain KM survived in soil following up to 5 megarads of γ irradiation. While the number of survivors was small, they might nevertheless be a factor in controlling growth of bacteria experimentally introduced into γ-sterilized soil. (auth)

44651 SUBSTERILIZING DOSES OF GAMMA IRRADIATION TO PRODUCE POPULATION SUPPRESSION IN PLUM CURCULIO. Jacklin, S. W.; Richardson, E. G.; Yonce, C. E. (Dept. of Agriculture, Fort Valley, Ga.). J. Econ. Entomol.; 63: 1053-7 (Aug 1970).

When Conotrachelus nenuphar (Herbst), reared in the laboratory on green thinning apples, were irradiated by ^{60}Co, longevity was reduced greatly when the dose was 8 krad, the amount necessary for complete sterilization of both sexes. However, when a substerilizing dose (6 krad) and a high overflooding ratio (40 treated males : 1 normal male : 1 normal female) were used, more than 60% of all males survived 3 weeks, and the number of larvae produced was decreased by 90%. Part of this reduction appeared to arise from harassment of the females by the great number of males. Testing of the sterile-release technique in the field appears to be justified. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 44219.

44652 (ORNL–4560) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1970. Patriarca, P. (comp.); Rucker, D. J. (ed.) (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 290p. Dep. CFSTI.

The results of research and development are summarized in 25 sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 44212, 44213, 44657–44659, 44670–44674, 44697–44699, 44742, 44760–44763, 44791, and 44816–44821.

44653 REACTOR MATERIALS. VOLUME 13, NUMBER 2. Simons, E. M.; Keller, D. L. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio; Battelle Memorial Institute. (Summer 1970). 47p. GPO $0.70.

Information on development of reactor materials is presented in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 44687, 44719, and 44770.

Corrosion and Erosion

Refer also to abstracts 43988, 43989, and 46091.

44654 (BNL–50205, pp 93-133) METALLURGY AND MATERIALS SCIENCE DIVISION. Gurinsky, D. H. (Brookhaven National Lab., Upton, N. Y.).

Efforts devoted to sodium technology were directed primarily toward testing fuel cladding materials for advanced LMFBR. Two forced circulation stainless steel loops were used to test several heat-resisting alloys. Data are presented tabularly from high-temperature tests conducted in these loops. Information is also included on impurity detectors for Na loops. Measurements were made on hysteresis in superconductors. Results of other studies are reported on phenomena at ≤0.1°K, and superconductivity in thin films. Investigations concerning the nature of radioinduced defects in metals and alloys are reported. (J.R.D.)

44655 (MDC-G-1675) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 5, October–December 1969. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Jan 1970. Contract AT(45-1)-2138. 15p. Dep. CFSTI.

Compatibility testing of relatively impure plutonia-238 in contact with six molybdenum, tungsten, and rhenium containing alloys at 1800 and 2000°C has shown that oxygen content of the plutonia affects reaction rates, and that significant amounts of oxygen are lost through the molybdenum alloy container walls. Further testing is currently underway with a higher purity plutonia representative of current production-grade material. Curia-244 has been encapsulated in primary containers with contamination free external surfaces for exposure at 2000°C. This approach, also used in the plutonia effort, provides a significant improvement in the determination of damage to the primary capsule. Plutonia-molybdenum cermets exposed for 1000 hours at 1800 and 2000°C in closed containers released approximately 40% of the stored helium. Longer duration exposure continues. (auth)

44656 (NP–10434) THE CORROSION OF MILDSTEEL, STAINLESS STEEL (18 Cr–8 Ni–1 Ti), AND INCONEL BY IODINE, TELLURIUM, SELENIUM, AND ANTIMONY VAPOURS. Project DRAGON. Horsley, G. W. (Atomic Energy Establishment, Winfrith (England)). May 1961. 23p. (DP-Report-36). Dep. CFSTI.

The consequences of deposition of and corrosion by fission products in the Dragon scavenge circuit are discussed. The results of corrosion tests at 350 and 500°C on mild steel, stainless steel (18Cr–8Ni–1Ti), and Inconel in certain fission product vapors suggested that the stainless steel was the most appropriate material for fabricating the scavenge circuit and that tellurium vapor was the most aggressive of the fission products. Mass transfer calculations show that the maximum corrosion rate of the scavenge circuit could be ~1.4 mil/yr. However, consideration of experimental evidence and the history of the fission products before they reach this component suggest that the corrosion rate in practice will be considerably smaller than the calculated rate. (auth)

44657 (ORNL–4560, pp 129-42) SODIUM CORROSION STUDIES. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

The partitioning of O between V alloys and Na was investigated at 600°C. The addition of Cr to V lowers the concentration of O entering into solid solution during equilibration with Na. The effect of O contamination on the creep rate of unalloyed V was determined at 600°C. The creep rate was higher in atmospheres containing a small partial pressure of O_2 (5×10^{-7} torr) than in ultrahigh vacuum. However, the addition of O to V before creep testing had a negligible effect on creep in the ultrahigh vacuum. A bimetallic thermal-convection loop composed of V and type 304 stainless steel was examined following operation with Na for 3000 hr at a maximum temperature of 700°C. Insert specimens of V increased in C, N, and O; the specimens of stainless steel were decarburized. The interstitial changes in the V specimens lowered elongation and increased yield strength at room temperature. The oxidation of type 316 and 304L stainless steel was studied at 760°C in 99% N_2–1% O_2 mixtures containing 100 ppM H_2O. Both alloys exhibited excellent resistance to scaling, and the oxidation resistance of type 316 stainless steel to oxidation was markedly better in this gas mixture than in moist air. The effect of Na leakage on the oxidation of type 304L stainless steel was studied in the N_2 + 1% O_2 mixture at 760°C. At relatively fast leakage rates, the escaping Na had only a small effect on the wall of the tubing and reacted mainly with surrounding thermal insulation. With smaller leaks, a film of Na_2O_2 was formed on the stainless steel surface and materially increased the oxidation rate. (auth)

44658 (ORNL–4560, pp 200-12) CORROSION STUDIES OF ADVANCED REFRACTORY METALS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

A T-111 forced-circulation loop (FCLLL-1) is being operated with Li at a maximum temperature of 1370°C and a temperature difference of 165°C. The test was interrupted after 1735 hr by a Li leak in a vent line leading to the hot leg. The leak and parts of the system damaged by the release of Li is being repaired. (auth)

44659 (ORNL–4560, pp 275-80) ADVANCED MATERIALS FOR STEAM GENERATORS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

A study is underway to investigate general and preferential corrosion of welds in steam at 595 and 650°C. Specimens have now experienced exposures of more than 10,000 hr. Weight gains were used to predict the amounts of corrosion to be expected after 20 years. Scale thicknesses were also measured and tabulated. It was found that the depth of the scales on Inconel 625, Hastelloy X, and IN 102 at 595 and 650°C, when they were used either as base metal or filler metal, never exceeded 3 μm except in the case of the IN 102 alloy used as base metal at 595°C. The scales formed on Incoloy 800 used as base metal and on Inconel 82 used as filler metal were comparable in thickness to those of the foregoing alloys. Scale thicknesses were greater on Hastelloy W used as filler metal and on Inconel 600. (auth)

44660 METHOD OF IMPROVING THE CORROSION RESISTANCE OF STAINLESS STEEL TO SODIUM. Smith, Fred A.; Kimont, Edward L. (to United States Atomic Energy Commission). U. S. Patent 3,514,344. 26 May 1970. Filed 3 Oct 1967.

A method is described of improving the corrosion resistance of nonstabilized Type 304 austenitic stainless steel to sodium at about 1000 to 1200°F by exposing the stainless steel to sodium at a temperature of over 1400°F for a period of at least 4000 hours. (auth)

44661 HIGH-TEMPERATURE OXIDATION OF ALUMINIUM IN VARIOUS GASES. Breakspere, R. J. (University Coll., Cardiff, Wales). J. Appl. Chem. (London); 20: 208-12(Jul 1970).

The oxidation of high-purity aluminum sheet in dry oxygen,

moist oxygen, carbon dioxide, and carbon monoxide (at total pressure 1.333×10^3 Nm^{-2}) was studied in the range 673 to 923°K, using a vacuum microbalance to follow weight gains. $^{14}CO_2$ and ^{14}CO were used to elucidate the mechanism of the oxidation in these gases and to estimate the extent of carbon deposition in the oxide layer. The rate of oxidation in moist oxygen was similar to that in dry oxygen, the principal reaction being $2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$. It is suggested that there are three steps in the reaction in CO_2, viz $2Al + 3CO_2 \rightarrow Al_2O_3 + 3CO$, followed by $2Al + 3CO \rightarrow Al_2O_3 + 3C$, and about 10% of the deposited carbon reacting further by $4Al + 3C \rightarrow Al_4C_3$. Only the last two reactions are operative in carbon monoxide. The Arrhenius plots showed a distinct break in the region 773 to 823°K for both carbon monoxide and carbon dioxide, but not for dry or moist oxygen. This is tentatively explained by a change in the rate-determining process from diffusion via grain boundaries or cracks in the oxide, to lattice diffusion. It is suggested that carbon may become mobile in the oxide film between 773 and 823°K and may tend to congregate in the grain boundaries and cracks. The oxide film remained protective throughout the duration of the experiments in all the gases. (auth) (UK)

44662 THERMAL CONVECTION LOOP TESTS OF Nb–1 PERCENT Zr ALLOY IN LITHIUM AT 1200 AND 1300°C. Sessions, C. E.; DeVan, J. H. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 250-9(Aug 1970).

The effect of temperature on the mass transfer of niobium alloys in lithium as determined in thermal convection loop tests to 1300°C is described. All loops were operated for 3000 hr in an ultrahigh vacuum environment. A consistent finding in these tests was the preferential movement of zirconium and nitrogen between heated and cooled regions, which in 1200°C tests accounted for most of the observed weight changes. At 1300°C transport of niobium was also reflected in the weight changes, and crystalline deposits of Nb(C,N) were found on hot-leg specimens. Examination of Nb–1% Zr specimens using an electron microprobe indicated the hot-leg surfaces to be depleted of zirconium to depths of 0.002 and 0.007 in. in 1200 and 1300°C tests, respectively. The results of calculations of the diffusivity of zirconium in niobium based on these data agree well with values predicted from extrapolation of higher temperature data. (auth)

44663 EFFECT OF APPLIED TENSILE STRESS ON THE CORROSION BEHAVIOUR OF ZIRCALOY-2 IN STEAM AND OXYGEN. Knights, C. F.; Perkins, R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 36: 180-8(Aug 1970).

A 1.2 to 2 fold enhancement of the corrosion rate of Zircaloy-2 in steam at atmospheric pressure by an applied tensile stress in the metal was observed at 475 and 400°C but not at 350°C. The effect did not occur during corrosion of unhydrided or pre-hydrided Zircaloy-2 in oxygen containing less than ≈300 ppM water vapor. The enhancement was interpreted in terms of an inhibition of the parabolic-to-cubic kinetic transition in the corrosion of Zircaloy-2 and a possible mechanism for this inhibition is discussed. (auth)

44664 USE OF CURRENT DENSITY AND POTENTIAL MEASUREMENTS IN CORROSION TESTS. Weber, J. (Sulzer AG, Winterthur, Switzerland). Schweiz. Arch. Angew. Wiss. Tech.; 36: 29-40(Feb 1970). (In German).

For corrosion measurements, a method is described which permits determination of two factors simultaneously. These factors are first, the electrical potential between metal surface and corroding liquid, and, second, current density caused by applied voltage. The technique is completely automatic. Voltage is applied in steps as potential and current density are transferred to punch tapes. The data on the punch tapes are transferred to magnetic tape or computer, and the tape is read by an xy plotter. Data obtained with various alloys and liquids are presented in 20 diagrams. The procedure already is used for monitoring corrosion caused by both chemical agents and mechanical stresses. (H.B.G.)

44665 IMPROVEMENT RELATING TO THE PROTECTION OF ZIRCONIUM AND ZIRCONIUM-BASE ALLOYS BY CHROMIUM ELECTROPLATING. (to Ugine Kuhlmann). British Patent 1,203,700. 3 Sep 1970. Priority date 17 Apr 1967, France.

Deposition of protective Cr coatings on Zr and Zr alloys is described. The alloy is immersed as a cathode in an electrolytic bath incorporating a Pb-base anode and an electrolyte solution containing CrO_3, $SrSO_4$, and SiF_6K_2. A current density of 5 to 40 A/dm^2 is used at a bath temperature of 10 to 40°C. (J.R.D.)

44666 PROTECTIVE COATINGS ON METALS. VOLUME 1. Samsonov, G. V. (ed.). New York; Plenum Publishing Corporation (1969). 137p. $15.00.

Translation of Zashchitnye Pokrytiya na Metallakh.

Twenty-five papers are included on the theory of diffusion, electrolytic coating methods, coating precipitation from gaseous phase, and coating by glow discharge. Methods for strengthening surfaces by nitriding, boriding, calorizing, carbiding, anodizing, siliciding, antimonizing and chromizing are examined. Methods for glass-ceramic deposition are discussed along with methods for graphite coating deposition. (J.R.D.)

44667 PROTECTIVE COATINGS ON METALS. VOLUME 2. Samsonov, G. V. (ed.). New York; Plenum Publishing Corporation (1970). 218p. $27.50.

Translation of Zashchitnye Pokrytiya na Metallakh by Z. S. Michalewicz.

An abstract for this collection of papers was prepared from the original language and appeared in NSA as 23: 29971. (J.R.D.)

44668 EFFECTS OF ALLOYING AND IRRADIATION ON THE OXIDATION BEHAVIOUR OF ZIRCONIUM ALLOYS. Campbell, C. S.; Tyzack, C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Brit. Corros. J.; 5: 172-7(Jul 1970).

Observations on the oxidation behavior of Zr–Nb alloys in pressurized H_2O at 300°C indicate a sensitivity to Nb content and to oxygen content of the water. This suggests a duplex-type oxide film, the inner portion being the normal hypostoichiometric n-type, changing under relatively oxidizing conditions in the outer layers to a hyperstoichiometric p-type containing interstitial oxygen ions resulting from the presence of Nb (V) ions. Preliminary work indicates that Zr-0.75 wt % Cr alloy exhibits a similar sensitivity to oxygen content of the water. Experiments on Zircaloy-2 in high temperature oxygenated H_2O containing Cr (VI) indicate doping of the zirconia films with Cr ions. Explanations are offered for the analogies observed, under oxidizing conditions, between the out-of-pile behavior of Zr–Nb alloys and the in-pile behavior of Zircaloy-2. (UK)

44669 STUDY OF THE OXIDATION OF Zr AT HIGH TEMPERATURES AND UNDER LOW O PRESSURES. Dechamps, Michel; Lehr, Pierre (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Compt. Rend., Ser. C; 270: 1933-6(15 Jun 1970). (In French).

The examination of the free surface and sections from zirconium samples oxidized at high temperatures and under low oxygen pressures indicates the occurrence of two phases. In the initial phase a thin oxygen layer is formed on top of the oxygen depleted zirconium oxide solid solution. In the second phase, if the pressure is in excess of 10^{-3} torr, a thick oxygen-saturated oxide layer spreads over the substrate. Alternatively, if the oxygen pressure is very low, anisotropy factors greatly influence the oxygen diffusion, thus playing an important part in the localization of the sites in which the thick oxide layer will be first produced. Under those conditions considerable time elapses before a thick continuous layer is established. (auth) (France)

Preparation and Fabrication

Refer also to abstracts 44164 and 44224.

44670 (ORNL–4560, pp 106-10) FABRICATION DEVELOPMENT FOR LMFBR STAINLESS STEEL TUBING. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Studies of the relations among processing variables, mechanical properties at elevated temperature, and physical defects of tubing were continued during the quarter. Varying the temperature of heat treatment between 750 and 775°C did not greatly influence the final grain size of Type 316 stainless steel. No significant differences were found in the stress-rupture properties at 650°C of Type 316 stainless steel with ultrafine grain size after 20% cold work and in the stress-relieved condition. In both conditions, the tubing had unusually high ductility for material not in the recrystallized condition. (auth)

44671 (ORNL–4560, pp 111-18) WELDING DEVELOPMENT FOR LMFBR VESSELS AND COMPONENTS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Studies of the submerged-arc welding process were continued in which multipass weldments in 1-in.-thick plate were prepared to investigate the effect of heat input on mechanical properties at elevated temperatures. Welds were also prepared using each of the four fluxes available commercially for the submerged-arc welding process in order to study the effect of flux composition on properties. Approximately 200 in. of weld in 1-in.-thick plate were produced for fracture-mechanics studies. Tests of

the mechanical properties of the experimental weldments are continuing. Initial tests show the submerged-arc specimens to be substantially weaker but to have higher ductility than the shielded metal-arc specimens. Several heat treatments are also being studied, including a solution anneal and an anneal plus aging to agglomerate carbides. Both treatments appear to improve ductility without decreasing rupture strength. Scanning electron microscope fractography shows a strong correlation between the solidification substructure and ferrite distribution and the fracture path and appearance. (auth)

44672 (ORNL-4560, pp 119-26) SHIELDING METAL-ARC WELDING FOR LMFBR COMPONENTS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

The "prototypic" Fast Flux Test Facility (FFTF) submerged-arc weldments in 2-in.-thick plate were completed. Tests of mechanical properties and fracture studies on 14 shielded metal-arc weldments are continuing. Although optical metallographic examination revealed no significant differences in microstructure, the properties of strength and ductility vary markedly. Aging before testing reduced ductility, confirming that the loss of ductility as a function of rupture time is an aging phenomenon. Third-stage creep was most strongly affected; as rupture life increased, a greater portion of the fracture surface showed fracture between phases. Formation of sigma phase is believed to be responsible for the lack of ductility. Additions of several minor elements resulted in strengthening: B, P, C, and Si in order of decreasing potency. (auth)

44673 (ORNL-4560, pp 186-97) TUNGSTEN METALLURGY. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

High-purity W sheet was produced by chemical vapor deposition for welding studies. Tubing and sheet of W-low Re alloys were also vapor deposited. Sheet containing 2% Re or less contained significantly fewer nodules than the W-5% Re material. In preliminary experiments, deposition of W with dispersions of TiO_2 was attempted by means of the reaction of a mixture of H_2, WF_6, $TiCl_4$, and H_2O gases. Continued studies showed that at 1650 and 2000°C the creep strength of W in 10^{-5} torr O_2 is lower than it is in a vacuum of 10^{-7} torr. Initial results from creep-rupture tests of high-purity chemically vapor deposited W at 1400, 1650, and 2200°C show significantly higher reduction in area at 2200°C for this material than was found in previous studies. Additional long-time creep data for arc-melted W, W-5% Re, W-26% Re, and W-25% Re-30% Mo showed lower values for the time to produce 1% creep than was previously predicted from the Larson-Miller parameters. In welding studies determinations were made of welding variables, preheat temperature, and stress-relief treatment needed to weld chemically vapor deposited W and arc-melted W-25% Re sheet successfully by the gas W-arc process. (auth)

44674 (ORNL-4560, pp 239-50) JOINING RESEARCH ON NUCLEAR MATERIALS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Data obtained at room temperature on the tensile properties of welds made in Incoloy 800 with commercial and experimental Incoloy 800 filler metals showed that an alloy nominally containing 0.02% P had the best reduction in area. The presence of nominally 0.015% S decreased both strength and ductility. All welds except that made with Inconel 82T, a commercial filler metal, failed in the weld metal. An investigation of the experimental Incoloy 800 type of alloys by means of the Duffers Gleeble showed that the hot ductility during heating is impaired by the presence of S. Low levels (0.01 to 0.04%) of C tend to lower the zero ductility temperature of the alloy and somewhat reduce the recovery of ductility during cooling. An extensive metallographic and electron-microprobe investigation is being conducted on experimental low-Ni alloys. Four alloys formulated to contain 0, 6, and 10% ferrite in an austenite matrix were examined after a homogenization treatment in H_2 for 1 hr at 1150°C. This study showed that the alloy designed to contain no ferrite (and containing Mn) did contain measurable amounts of ferrite. The alloys with different levels of Ni and Cr that were designed to contain ferrite did contain it; however, the size and distribution were considerably different. An electron-beam microprobe analysis revealed a ratio of Ni:Cr of 1.5 in the austenite matrix, regardless of the nominal composition of the alloy. (auth)

44675 (USBM-RC-1394) PREPARATION OF SINTERED TUNGSTEN-25 RHENIUM AND W-Re-Mo ALLOY SLEEVES. Period [Covered], November 1, 1963-June 30, 1967. Asai, G.; Thomas, C. R. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Jan 1969. Contract AT(11-1)-599. 102p. Dep. CFSTI.

Work was done to establish a procedure for preparing sintered W-25Re and W-Re-Mo alloy sleeves for use as tube-extrusion blanks. Minus 325 mesh commercially pure metal powders having particle sizes ranging from 1 to 5 microns (Fisher subsieve) were sintered in H_2 or vacuum at temperatures ranging from 1,500 to 3,000°C. The results of this work showed that W-25Re and W-29.45Re-18.2Mo (W-25Re-30Mo, atomic percent) can be dry blended and sintered at 2,400°C to reproducibly obtain sleeves free of second phase and with consistent composition, density, and grain size. The results also showed that W-35.3Re-18.2Mo mixtures similarly processed occasionally resulted in sleeves having traces of sigma phase. (auth)

44676 FINE-GRAIN BERYLLIUM PARTICULATE COMPOSITES. (to P. R. Mallory and Co. Inc.). British Patent 1,202,129. 12 Aug 1970. Priority date 15 Sep 1967, United States.

Preparation of a ductile Be composite is described which is composed of 60 to 85% Be, 12.75 to 39.5% Al, 0.10 to 3.6% Mg and 0.08 to 1.5% Si. The composite retains the strength and low density of Be and the ductile matrix allows continuous deformation under load. (J.R.D.)

44677 PROCEEDINGS OF THE SECOND COLLOQUIUM ON THIN FILMS, BUDAPEST, 1967. Hahn, E. (ed.). Goettingen, Ger.; Vandenhoeck and Ruprecht (1968). 641p. Lw. DM 118,--. (In several languages). (CONF-670673).

The conference on thin films covers the formation and structure of films, optics of thin films, the physical and chemical properties, and the use of thin films with special regard to electric components. (J.F.P.)

44678 HIGH-HOT-STRENGTH VANADIUM-BASE ALLOY. Keith, G. H.; Winston, J. S. (Reno Metallurgy Research Center, Nev.). Metals Eng. Quart.; 10: No. 3, 56(Aug 1970).

Development of V-base alloys superior in tensile properties to Ni-base and Co-base superalloys was investigated. A V-base alloy composed of Mo-20%, Ti-10%, C-0.1%, Si-0.5%, and Y-0.5% is described which has exceptional strength to 1200°C. (J.R.D.)

44679 NEWER TECHNIQUES IN THE FABRICATION OF REFRACTORY AND REACTIVE METAL TUBING. Isserow, S.; Loewenstein, P.; Huber, R. F. (Whittier Corp., West Concord, Mass.). Metals Eng. Quart.; 10: No. 3, 56-8(Aug 1970).

Extrusion techniques used in control of geometry as a result of streamlined flow of materials through conical dies or between conical dies and mandrels are described. Planetary ball swaging as a finishing process for tubing is also described. Extrusion examples using B-66, T-111, and Cb-752 are discussed. (J.R.D.)

44680 BRAZING APPLIED TO THE DEVELOPMENT AND MANUFACTURE OF NUCLEAR FUEL ELEMENTS. Sheward, G. E. (United Kingdom Atomic Energy Authority, Preston, Eng.). Weld. J. (N. Y.); 49: 548-54; 557-8(Jul 1970).

The evaluation and application of basic joint data are given. This facet of the work includes corrosion experiments with CO/CO_2, steam, and sodium. Results for long term exposure in these environments are briefly discussed and include the microprobe analysis of joints exposed to flowing sodium. Mechanical properties of commercially available braze metals at room and elevated temperatures have been determined, and results of shear strengths of these are presented. Specimens brazed and then heat treated at various temperatures and times with varying joint gaps have been evaluated by measurement of remelt temperatures and by Charpy impact tests. The results of these are tabulated and briefly discussed. The type of specimen used and the experimental techniques used for remelt temperature determination are briefly described. (auth)

44681 MEASUREMENT AND INTERPRETATION AND APPLICATION OF PARAMETERS IMPORTANT TO ELECTRON BEAM WELDING. Sandstrom, D. J.; Buchen, J. F.; Hanks, G. S. (Los Alamos Scientific Lab., N. Mex.). Weld. J. (N. Y.); 49: 293s-300s(Jul 1970).

An investigation was conducted to define the physical properties of materials and operational features of electron beam welding equipment to better describe the welding process. It was found that for thin gage material, low voltage-high current should be used. High power density appears to aggravate spiking defects. Precise penetration and control of root characteristics can best

be achieved by multipass low power procedures. Melting appears to be dependent on power density in the electron beam. (J.R.D.)

44682 HIGH-STRENGTH LOW-TEMPERATURE BONDING OF BERYLLIUM AND OTHER METALS. Knowles, J. L. (Univ. of California, Livermore); Hazlett, T. H. Weld. J. (N. Y.); 49: 301s-10s(Jul 1970).

An investigation has been carried out to determine the feasibility of developing techniques for bonding beryllium as well as other metals at low temperatures and to establish the relationship of the bond parameters to the bond strength. It may be concluded that bonds (exhibiting beryllium fracture strength of 40 ksi) on beryllium plated with 500 μin. of silver (especially prepared after plating) can be made at 225°F. The data also invalidate a conclusion reached in at least one other investigation that the minimum theoretical temperature for such bonding is 390°F, i.e., the temperature at which Ag_2O decomposes. Experimental data indicate that an adhesion or cohesion model is the bonding mechanism. This conclusion is based on the linear relationship of the bond strength-to-bonding compressive stress and the independence of bonding time. Bond strengths are dependent upon the thickness of the plating; bond strengths increase with increasing thickness up to 600 μin. (J.R.D.)

44683 PREPARING PLUTONIUM FOR OPTICAL MICROSCOPY: A PRECIS. Part I. Cochran, F. L. Microstructures; 1: 15-19; 40(Aug-Sep 1970).

A review of optical metallography development and practices used with Pu is presented. Information is included on glove box design, physical properties of Pu, and metallographic techniques such as mounting. Basic laboratory equipment is described. (J.R.D.)

44684 SPARK MACHINING OF BERYLLIUM. Brewer, A. W. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Microstructures; 1: 25-8(Aug-Sep 1970).

An investigation was conducted to ascertain the effects of spark-machining (EDM) on beryllium ingot sheet. Specific emphasis was placed on the depth of damage caused by the spark-machining process. It was found that the EDM process generally caused less damage to the beryllium surface than is caused by the single point machining process now used. However, EDM is much slower in removing metal than a lathe. (auth)

44685 ELECTRODEPOSITION OF IRON–NICKEL–MOLYBDENUM TERNARY ALLOYS. Ilyushenko, L. F.; Gribkovskaya, L. G. (Inst. of Physics of Solids and Semiconductors, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 121-4(1969). (In Russian).

The chemical composition of electrodeposited films of Fe–Ni–Mo alloys and their magnetic characteristics were studied as a function of composition of the electrolyte bath, the pH of the electrolyte, and the cathode current density. (R.V.J.)

44686 METHOD FOR FILLING ALKALI METALS INTO IRRADIATION CAPSULES. Dorner, S.; Katheder, H. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik; 12: 273-9 (Jul 1970). (In German and English).

A facility and a method are described for filling sodium or NaK into irradiation capsules. The facility makes it possible to fill and then immediately to seal the capsule under cover gas. The sodium or NaK is filled in through a stainless steel funnel, with a frit fitted into the outlet, attached leak-tight to the irradiation capsule. The sodium is first melted down in the funnel by induction heating, and is then forced through the frit with helium. This filtering purifies the sodium. The capsule is sealed by simultaneous fusing and high frequency induction welding of a narrow tube connecting the capsule and the funnel. The method may also find application in producing the so-called bonding in fuel rods. (auth)

44687 SPECIAL FABRICATION TECHNIQUES. Reactor Mater.; 13: 92-105(Summer 1970).

Results of recent innovations in reactor materials fabrication methods are reviewed. Information is included on powder metallurgy, melting, casting, welding, brazing, nonelectrolytic plating, electroplating, and explosive metal working. Development of nondestructive testing methods are also reviewed. Information is included on ultrasonic methods, infrared methods, and eddy current methods. (J.R.D.)

44688 TOTAL QUALITY APPROACH FOR PRESSURE VESSELS. Proctor, Edward S. (Combustion Engineering Inc., Chattanooga). Metal Progr.; 98: No. 2, 80-4(Aug 1970).

Procedures are outlined in which incoming plates and forgings are checked for defects; welds are examined during fabrication; and completed vessels are proved out for long-term usage. Methods are discussed for quality planning and in-line inspection. (J.R.D.)

44689 PREPARATION AND PROPERTIES OF BULK $In_{1-x}Ga_xAs$ ALLOYS. Wagner, John W. (Bell and Howell Co., Pasadena, Calif.). J. Electrochem. Soc.; 117: 1193-6(Sep 1970).

Single crystals of $In_{1-x}Ga_xAs$ were grown by Czochralski techniques for $0.0 \leq x \leq 0.2$ and $0.8 \leq x \leq 1.0$. Polycrystalline single-phase $In_{1-x}Ga_xAs$ material has also been pulled for $0.2 < x < 0.8$. Two Czochralski techniques, the sealed system or Gremmelmaier technique, and the liquid encapsulation technique were used. Mass spectrographic data were correlated with alloy lattice parameter determinations on the as-grown material to yield information on the solidus curve of the InAs–GaAs system. Hall measurements were made and impurity analyses were performed using the spark source mass spectrometer. (auth)

44690 HIGH PURITY NIOBIUM THROUGH ALUMINOTHERMIC REDUCTION OF NIOBIUM PENTOXIDE. Gupta, C. K. (Bhabha Atomic Research Center, Bombay); Jena, P. K. Trans. Indian Inst. Metals; 22: No. 4, 51-2(Dec 1969).

A method is presented for obtaining massive niobium metal from its pentoxide by aluminothermic reduction at a comparatively low temperature by using a small amount of calcium and sulfur as the reaction trigger. Analysis of the as-reduced metal sample showed considerable contamination with Al, C, N, and O but further processing by electron beam melting resulted in considerable purification. The hardness of the melt-refined niobium was as low as 90 to 100 DPH and its density was 8.48 gm/cc. (D.H.M.)

44691 SIMPLE APPARATUS FOR DC BIAS SPUTTERING. Bomer, R. P.; Beck, A. H. (Cambridge Univ., Eng.). Vacuum; 20: 285-90(Jul 1970).

A system for the deposition by sputtering of thin tantalum films of fairly high purity is described, which was easily and cheaply constructed. It would be equally suitable for sputtering films of other refractory metals. The films produced have superconducting transition temperatures in the range 3.4°K to 3.8°K, and the ratio of the resistance at 290°K to the resistance at 77°K is within the range 1.15 to 1.5. They are reproducible and physically durable. (auth) (UK)

44692 METHOD AND APPARATUS FOR PRODUCING COATED PARTICLES. Vondra, Benedict Lorenz; Baker, Donald Earl; Eck, John Edward; Haley, Thomas Edward (to Nuclear Materials and Equipment Corp.). British Patent 1,201,845. 12 Aug 1970. Filed 4 Mar 1968.

Reference is made to the production of coated particles by the vapor deposition process. Both the particles and the coatings may be metallic or ceramic; examples are particles of U and its oxides and carbides, with coatings of Ta, W, Mo, Zr, Al and their oxides. The object of the process described is the production of uniformly coated particles. When attempting to coat by the conventional electron beam bombardment technique, or in other ways, which give rise to a substantially point source of vapor, difficulty may be experienced in producing uniform coating. The process arose from the realization that the coating vapor is emitted from the electron-beam target in approximately linear streams; a particle injected into the stream is coated to a greater extent on the portion of its surface which the streams impinge and to a lesser extent on the surface away from the stream. In the modified process the particles are passed through the coating vapor in such a way that their attitude to the vapor is repeatedly changed and they are recycled through the vapor by repeated injection and reinjection. In conventional processes the coatings also behave in an unpredictable way, with tendencies to agglomeration and sticking of the particles. This is overcome in the present process by giving a periodic motion to the particles. The required apparatus is described in detail, including a particle conveyor and its associated drive mechanism. (UK)

44693 COBALT–SAMARIUM PERMANENT MAGNETS PREPARED BY LIQUID-PHASE SINTERING. Benz, M. G.; Martin, D. L. (General Electric Co., Schenectady, N. Y.). Appl. Phys. Lett.; 17: 176-7(15 Aug 1970).

The preparation and measurement of magnetic properties of cobalt-samarium permanent magnets prepared by liquid-phase sintering are discussed. Energy products in excess of 15×10^6 were observed. Long time exposure to air at 150°C did not degrade the samples. (auth)

Properties Evaluations

Refer also to abstracts 43934, 43991, 44026, 44214, 44215, 44745, 44780, 44787, 45349, 45354, and 46034.

44694 (DP-1051(Rev.2)) PROPERTIES OF ^{60}Co AND COBALT METAL FUEL FORMS. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jun 1968. Contract AT(07-2)-1. 35p. Dep. CFSTI.

A compilation of properties of ^{60}Co and cobalt metal is presented including information on compatibility of cobalt with encapsulating materials. In general, data on properties are reported for unirradiated cobalt metal, and data specific to radioactive cobalt are so indicated. Data for high temperature fuel forms other than metallic cobalt (melting point-1495°C) are limited at present and are not included. Cobalt-rhenium alloys and solid solutions of cobalt and magnesium oxides offer the possibility of higher melting point fuel forms with reasonable power density. However, development of these forms has been deferred because of the applicability of cobalt metal for most near-term uses. (auth)

44695 (HSSTP-TR-8) CRACK ARREST FRACTURE TOUGHNESS OF A533 GRADE B CLASS 1 PRESSURE VESSEL STEEL. Crosley, P. B.; Ripling, E. J. (Materials Research Lab., Inc., Glenwood, Ill.). Mar 1970. Contract W-7405-eng-26; Subcontract 3152. 53p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Crack initiation and crack arrest toughness measurements for ASTM A 533 Grade B, Class 1 steel were made using Heavy Section Steel Technology program material. At -70°F there was little difference between static initiation, dynamic initiation, and crack arrest toughness values. All fell in the range of about 40-45 ksi-$\sqrt{\text{in.}}$ At 0°F dynamic initiation and crack arrest toughness values were both of the order of 60 ksi-$\sqrt{\text{in.}}$ Static initiation values were generally higher, ranging to above 80 ksi-$\sqrt{\text{in.}}$ Initiation toughness values could be altered by changing the fatigue precracking procedure or by pre-stressing a specimen prior to testing; the arrest toughness was not sensitive to these changes. It seems likely that at higher temperatures the arrest toughness could be distinctly lower than the dynamic initiation toughness; a few tests run at room temperature are consistent with this possibility. (auth)

44696 (NP-18354) A FORTRAN IV CALCULATOR PROGRAM FOR PREDETERMINATION OF THE CREEP COLLAPSE OF THIN WALLED TUBES. Buerkle, G.; Kaupa, H.; Schneider, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). May 1970. 14p. (In German). Dep. CFSTI (U. S. Sales Only).

A computer program is reported, by which the creep buckling behavior of thin-walled tubes, for instance claddings for a steam- or gas-cooled reactor, can be calculated. The basis of the program is a differential equation of the velocity of buckling. This equation is the result of Hoff's theory, which describes the buckling of tubes at high temperature under external pressure by means of a sandwich model. The calculation contains steady correction of the creep constant K according to Norton's creep law as it is used in Hoff's theory to get equal creep velocities, since the integration of the differential equation requires integer n-parameters. Printed results of the calculation are the life times of the tube until complete buckling or any grade of buckling for discrete steps of external pressure. (auth)

44697 (ORNL-4560, pp 173-8) CLADDING MATERIALS FOR SPACE ISOTOPIC HEAT SOURCES. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

The tensile properties of two experimental V-Co-Ni alloys were determined at high temperatures; the ordered alloy was found superior to the disordered alloy and much less sensitive to temperature. Alloys of Pt and Ir alloys were prepared for evaluation, and the oxidation of one, Pt-21 at. % Cr-4 at. % W, was determined at 1000°C in air. Capsule shapes were fabricated from Nb-1% Zr, Mo, and Mo-0.5% Ti by back extrusion at 1200°C. The use of Mo coatings and higher temperatures are being evaluated in an attempt to back extrude Ta-10% W and T-111 capsules. (auth)

44698 (ORNL-4560, pp 179-85) PHYSICAL AND MECHANICAL METALLURGY OF REFRACTORY ALLOYS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

An apparatus for measuring the creep properties of T-111 in low-pressure N_2 is nearing completion. The hardness of Ta-65% Hf was found to increase in diamond pyramid hardness by about 250 as a result of aging for 7 min at 850°C. An electron-beam-melted ingot of this alloy can be cold forged without difficulty. A Ta-40% Zr alloy was prepared for x-ray studies to verify whether a miscibility gap exists in the system. Rupture times for welds of T-111 are equal to those for the base metal at low stresses but are shorter at high stresses. The creep properties of C-129Y were measured at 980, 1095, and 1205°C. Studies on the remelt temperatures of filler metals for brazing continue. The thermal conductivity, electrical resistivity, and thermopower of Ta-5% W were measured between 80 and 400°K. (auth)

44699 (ORNL-4560, pp 261-74) IMPROVEMENT OF HASTELLOY N AND RELATED COMPOSITIONS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Laboratory melts and small commercial melts of Hastelloy N modified with Ti, Nb, and Hf were irradiated at 760°C to a thermal fluence of 3×10^{20} neutrons/cm^2. Several alloys had good properties after irradiation, and electron microscopy revealed the presence of finely dispersed carbides of the MC type in these alloys. The addition of Si causes the formation of large carbides of the M_6C type. If the concentration of Ti, Nb, and Hf is high enough, fine carbides of the MC type are also formed when Si is present. (auth)

44700 (ORNL-TM-3028) SOME CREEP-RUPTURE DATA FOR NEWER HEATS OF HAYNES ALLOY NO. 25 (L-605). Swindeman, R. W. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

A number of exploratory creep- and stress-rupture tests were performed on four newer heats of Haynes alloy No. 25, over the range 649 to 1316°C. Melting practice included air, vacuum, and electroslag processes. The results confirmed that existing literature data were adequate. The rupture strengths of weldments produced in three of the heats fell within the scatter band for the base metal. (auth)

44701 (ORNL-TM-3030) SIZE EFFECTS AND ENERGY DISPOSITION IN IMPACT SPECIMEN TESTING OF ASTM A 533 GRADE B STEEL. Witt, F. J.; Berggren, R. G. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 42p. Dep. CFSTI.

A series of impact type specimens ranging in thickness from 0.1 to 12 in. were tested. The effects of size on the impact energy per unit volume of the plastically deformed material of the specimens tested were investigated using the laws of similitude. Complementary to this a model illustrating the disposition of energy between shear lip and flat fracture was proposed and satisfactorily verified by the test results. It is shown that significant size effects on impact energy existed at all temperatures and in particular a size effect of around five existed even at upper shelf temperature for 12-in.-thick impact specimens when compared to the energy from thinner specimens, say a Charpy impact specimen. This is to say that on the upper shelf the impact energy of a 12-in.-thick specimen was equivalent to between 25 and 30 ft-lb Charpy impact energy. To lend further support to the behavior thus defined it was shown that the nil ductility type (NDT) behavior in 12 in. thicknesses was exhibited at around 145°F as compared to the similar behavior exhibited by regular drop-weight specimens at around 0°F. That is, the NDT, if redefined as a type of behavior and not confined to a given size specimen, for 12-in.-thick plate is 145°F. (auth)

44702 (SC-RR-70-371) A STUDY OF THE STRESS CORROSION CRACKING BEHAVIOR OF MULBERRY (U-7.5 WT % Nb-2.5 WT % Zr). Magnani, Nicholas J.; Romero, Herman; Miglionico, Charles J. (Sandia Labs., Albuquerque, N. Mex.). May 1970. 35p. Dep. CFSTI.

An investigation of the uranium base alloy, Mulberry (nominal composition of 90 wt% U, 7.5 wt% Nb, and 2.5 wt% Zr) was conducted to characterize the stress corrosion cracking behavior of the alloy. Two stress corrosion cracking modes were observed: quasi-cleavage (transgranular) and intergranular. The transgranular mode required O_2 for propagation and had a critical stress intensity for crack propagation of approximately 20 KSI/in. The intergranular mode occurred both in high relative humidity air and in an aqueous environment. The critical stress intensity for crack propagation of the intergranular mode is below 10 KSI/in. (auth)

44703 (UCRL-19196) ENHANCEMENT OF SUBSTRUCTURE STRENGTHENING OF MARTENSITE. Cheng, I-lin (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 90p. Dep. CFSTI.

Thesis.

The structure and mechanical properties of two types of precipitation hardenable austenite alloys were studied. One was based on Fe-22Ni-4Mo-0.28C where the precipitates were Mo_2C and the other was Fe-28Ni-2Ti where the precipitates were coherent fcc

γ' (Ni_3Ti) ordered phase. Both types of alloy could be transformed martensitically in liquid nitrogen, thus rendering possible the study of the effect of precipitates on the substructures of martensite and the kinetics of martensitic transformation. It was found that the substructure strengthening effect of martensite could be enhanced by dispersion hardening the austenite prior to martensitic transformation. In addition, the stabilities of the austenitic alloys were such that upon certain aging treatments, the alloys transformed partially to martensite (due to precipitation of solute atoms), thus the mechanical properties of these composite materials could be evaluated in terms of the strengthening effect of each of the component phases. Upon straining, martensite formed in both types of alloys and microstructure observations were then made. (auth)

44704 (UCRL-72321) INFLUENCE OF STRAIN RATE ON FLOW STRESS OF TANTALUM. Hoge, K. G. (California Univ., Livermore. Lawrence Radiation Lab.). 24 Jul 1970. 8p. (CONF-700813-1). Dep. CFSTI.

From 2nd International Conference on Strength of Metals, Monterey, Calif.

The influence of strain rate on the flow stress of 99.9% pure, fully recrystallized tantalum is examined. Stress-strain curves in both tension and compression are obtained at strain rates from 10^{-5} to 5,000 sec^{-1}. The dependency of the upper and lower yield stress on strain rate is closely predicted by the Johnston–Gilman model. However, this model does not adequately describe post-yield hardening behavior. The Dorn–Rajnak model appears to describe the dynamic behavior better; it not only predicts yield behavior accurately but provides an excellent description of post-yield behavior. (auth)

44705 (UCRL-72544) EFFECTS OF TEMPERATURE, STRAIN, AND STRAIN RATE ON THE MECHANICAL PROPERTIES OF PLUTONIUM–1 WT. PERCENT GALLIUM DELTA-STABILIZED ALLOYS. Barmore, Willis L.; Uribe, Frank S. (California Univ., Livermore. Lawrence Radiation Lab.). 22 Jun 1970. 16p. (CONF-701001-4). Dep. CFSTI.

From 4th International Conference on Plutonium and Other Actinides, Santa Fe, N. Mex.

Various testing methods were used to obtain the mechanical properties of Pu – 1 wt % Ga δ-stabilized alloys. Stresses ranged from 250 to 20,000 psi, temperatures from 23 to 600°C, and strain rates from 10^{-5} to 10^{-1} sec^{-1}. Effects on mechanical properties of stress, temperature, and mechanical and thermal histories were studied. Strength properties obtained from compression, tension, shearing, and torsion tests were analyzed and compared, and the results are in close agreement. The flow stress increased with increasing strain rate and decreased with increasing temperature, indicating that one or more thermally activated deformation mechanisms control plastic deformation in this domain of testing. (auth)

44706 STRUCTURE AND MECHANICAL PROPERTIES OF FIRE GRAIN DEFORMED BERYLLIUM. Papirov, I. I.; Tikhinskii, G. F. Fiz. Metal. Metalloved.; 29: 1057-60(May 1970). (In Russian).

Methodical deformation of cast beryllium (99% pure) produced a metal with grain dimensions 13 μ and controlled its mechanical properties and ductility at 20 to 1000°C. At room temperature the strength is equal to 56.5 kg/mm^2 and the relative ductility is 7.5%. Tests on compression resistance reached 150 kg/mm^2; disintegration does not appear up to ~50% deformation. The good mechanical properties of beryllium were due to the fine grain and low impurity content. (tr-auth)

44707 USE OF URANIUM AS A SHIELDING MATERIAL. Blasch, Earl B.; Stukenbroeker, George L.; Lusky, Robert J.; Bonilla, Charles F.; Berger, Harold. Nucl. Eng. Design; 13: 146-82(Jul 1970).

Specific uses of uranium in shielding materials in relation to cost and/or weight savings realized in various designs are discussed. Information concerning commercial grades and forms of U and fabrication methods are included. (J.R.D.)

44708 USE OF LEAD AS A SHIELDING MATERIAL. Stukenbroeker, George L.; Bonilla, Charles F.; Peterson, Ruben W. Nucl. Eng. Design; 13: 3-145(Jul 1970).

The properties of lead and lead alloys used as shielding materials are examined. Data are included on isotopic variations of lead, specifications for grades of pig lead, and properties and uses of lead alloys. (J.R.D.)

44709 CURRENT AND PROSPECTIVE APPLICATIONS FOR BERYLLIUM. Terry, Emory L. (Brush Beryllium Co., Cleveland). Metals Eng. Quart.; 10: No. 3, 53-6(Aug 1970).

The production, development, and potential uses of Be are reviewed. Information is included on design requirements based on thermal and mechanical properties. Development of Be for aircraft disk brakes is discussed. (J.R.D.)

44710 EFFECTS OF HYDROSTATIC PRESSURE ON MECHANICAL BEHAVIOR OF BERYLLIUM. Aladag, Erdem. Cleveland; Case Western Reserve Univ. (1968). 137p. Thesis.

Two types of polycrystalline beryllium — powder metallurgy (pm) and ingot — have been studied at room temperature by straining in tension to fracture under hydrostatic pressure up to 10 kilobars (Kb) at a constant strain rate. The true stress-strain curves at pressure were obtained to elucidate the flow and fracture characteristics and to improve the understanding of the nature of low ductility in beryllium. The two types of metallurgically-well-characterised beryllium were chosen to study also the influence of several metallurgical variables such as grain size, preferred orientation and impurity on the mechanical behavior under pressure. Microstructural studies with the use of electron fractography, thin-foil electron transmission microscopy and optical microscopy were conducted to supplement the interpretation of the results obtained from the mechanical testing. The yield behaviors of both pm and ingot Be are found to be unaffected by pressure. This observation is in agreement with the current theoretical ideas on the effect of pressure on yield and flow stresses in metals. The work hardening of the pm Be remains unaltered with pressure, whereas a considerable increase occurs in the flow stress of ingot Be. This increase is attributed to the development of sessile vacancy loops during plastic straining under pressure rather than the direct effect of pressure upon dislocation mobility which is considered to be low for metals. In addition to the conventional basal and prism slip in beryllium two new deformation sub-structures — pyramidal slip and microkinking — were revealed. Both of these features are considered to contribute to the true three-dimensional ductility observed for beryllium. The increase in ductility and the ductile-brittle transition under pressure is explained in view of the true fracture stress and work hardening behavior at pressure. It was shown that the ductility of the ingot Be increases linearly at a high rate with pressure. In the case of the pm Be the ductility increases slowly up to 6 Kb above which the increase becomes similar to that of ingot Be. The pressure dependence of the fracture stress of polycrystalline beryllium is in qualitative agreement with the recently proposed theory of Francois and Wilshaw (F–W) using the split-bend plane model of Stroh–Friedel. The fracture stress of the ingot Be is approximately proportional to the pressure, whereas for the pm Be the fracture stress exhibits a transition from a low to a large pressure dependence at about 6 Kb. Slightly larger dependence of the fracture stress for the ingot Be and the pm Be (above 6 Kb) than the one predicted by F–W shows that the effect of pressure and plastic deformation on the effective surface energy for crack propagation can be significant. The electron fractography revealed transgranular fracture for all of the ingot Be specimens. In the case of the pm Be the fracture is predominantly intergranular up to 6 Kb above which the fracture becomes predominantly transgranular. Prestraining in tension under pressure is found not to improve the total strain to fracture of the ingot Be tested subsequently at atmospheric pressure. This observation infers that unlike the results obtained for the ductile materials like mild steel and aluminum by Bridgman and Pugh, respectively, the decrease in the amount of internal damage during prestraining under hydrostatic pressure does not contribute to the total strain in the case of the brittle metal beryllium. Microcracks are observed to develop in the structure of the ingot Be at all pressures except at atmospheric pressure. The density of these microcracks decreases with pressure for a given plastic strain and increases with the amount of straining at a given pressure. No microcracks were observed in the pm Be. (Diss. Abstr. Int., B)

44711 TIME-TEMPERATURE PARAMETERS FOR CREEP-RUPTURE ANALYSIS. Papers from Two Sessions Presented at the Materials Engineering Congress, Detroit, Michigan, 14 October 1968. ASM Publication No. D8-100. Metals Park, Ohio; American Society for Metals (1968). 392p. (CONF-681081).

Eleven papers were presented at the conference. A separate abstract was prepared for one paper. Papers for which no abstracts were prepared are concerned with time–temperature parameters, creep-rupture of steels, extrapolation of time-to-rupture of alloys, creep-rupture of steels and superalloys, extrapolation of rupture data on steels, elevated temperature property prediction, materials acceptance criteria, and creep-rupture of Al alloys. (J.R.D.)

For an abstract of one paper see: 44794.

44712 CRASH: A COMPUTER PROGRAM FOR THE EVALUATION OF THE CREEP AND PLASTIC BEHAVIOR OF FUEL-PIN

SHEATHS. Guyette, M. (Belgonucleaire, Brussels). Nucl. Appl. Technol.; 9: 60-9(Jul 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

The computer program CRASH allows the calculation of triaxial stress and strain states in the sheath of cylindrical fuel elements when creep or plasticity occurs in the cladding material. Any creep or plasticity law may be used in the program and any type of external stresses and strains assumed. A short description of the program is given. Program applications are illustrated by examples of analyses of plastic thermal ratcheting under cyclic conditions and creep of cladding due to contact pressure. These examples show that the CRASH program is a useful and flexible tool for the cladding design of fuel elements. Moreover, its calculation time is sufficiently small as to allow intensive parametric studies. (auth)

44713 ENVIRONMENTALLY AGGRAVATED FATIGUE CRACKING OF ZIRCALOY-2. James, Lee A. (Battelle Northwest Lab., Richland, Wash.). Nucl. Appl. Technol.; 9: 260-7 (Aug 1970).

The fatigue crack propagation behavior of Zircaloy-2 subjected to various environmental conditions was examined within the framework of linear elastic fracture mechanics. It was found that the fatigue crack growth rate increased with increasing levels of cold-work, increasing temperature, and exposure to a water environment. (auth)

44714 INFLUENCE OF TEMPERATURE ON SLIP BEHAVIOUR OF MOLYBDENUM SINGLE CRYSTALS DEFORMED IN TENSION IN THE RANGE FROM 293 TO 573°K. I. STRESS-STRAIN CHARACTERISTICS. Richter, J. (Deutsche Akademie der Wissenschaften, Berlin. Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Phys. Status Solidi; 40: 565-72(1 Aug 1970).

Cylindrical molybdenum single crystals of middle orientation (Schmid factor ≈ 0.5 on the (101)[11$\bar{1}$] slip system) grown by electron zone melting were deformed in tension at various temperatures between 293 and 573°K using a strain-rate of 7×10^{-6} sec^{-1}. Stress-strain curves are parabolic in shape below 340°K ($T < 0.12\ T_m$), whereas they are clearly divided into three work-hardening stages above 400°K ($0.14\ T_m < T < 0.20\ T_m$). The variation of yield stress and work-hardening parameters in dependence on deformation temperature is systematically investigated and the results are discussed with respect to published work on other bcc metals. Furthermore, molybdenum crystals with various specially chosen "single slip" orientations were deformed at 493°K. It is found that under these conditions the orientation has no pronounced influence on the stress-strain curve. (auth)

44715 PRESSURE-COMPOSITION-TEMPERATURE STUDY OF THE ZIRCONIUM/2.5 WT. PERCENT NIOBIUM + HYDROGEN SYSTEM. Sinha, Vijay Kumar; Singh, Kamala Prasad (Indian Inst. of Tech., Kanpur). J. Nucl. Mater.; 36: 211-17(Aug 1970).

The solubility of hydrogen was determined in the (Zr + 2.5 wt % Nb)-H_2 system as a function of composition, temperature (300 to 950°C) and hydrogen equilibrium pressure (0.5 to 760 mm Hg). From the isotherms, the position of the boundaries $\beta - (\beta + \delta)$ and $(\beta + \delta) - \delta$ were determined. The presence of niobium seemed to shift these boundaries to lower hydrogen values and raise the hydrogen equilibrium pressure in the two phase region $(\beta + \delta)$. The equilibrium pressure temperature relation in the two-phase region $(\beta + \delta)$ was derived to be, $\log_{10} p = -12\ 020/T + 13.39$, where p is measured in mm Hg and T in degrees Kelvin. The heat of formation of δ-hydride from saturated β-Zr was -54.8 kcal/mole H_2, as compared to -49.1 kcal/mole H_2 in unalloyed zirconium-hydrogen. (auth)

44716 SPECIFIC INFLUENCE OF ADDITIONS TO URANIUM ON IN-PILE GROWTH. Baron, Jean-Louis; Cadalbert, Robert (CEN, Saclay, France). J. Nucl. Mater.; 36: 123-34(Aug 1970). (In French).

The irradiation growth coefficient g in the [010] direction was determined for a number of binary uranium alloys after reactor growth of polycrystalline specimens with strong preferred orientations. These preferred orientations, established by x-ray diffraction, allowed the evaluation of growth indices G2 and G3, which are required for the calculation of g. The experiments were done in capsules held isothermally at temperatures between 450 and 500°C. Substantial differences were found between the values of g for the different alloys examined: for instance at 450°C some alloys showed a rate of growth about three times less than that of pure uranium; others, on the other hand, grew twice as fast as pure uranium. There is a discussion of the possible influence on the results of incidental effects such as texture modifications and plastic flow under irradiation. It is possible to show moreover that the rate of growth varies with the temperature in different ways for different alloys; this variation seems to depend more on the nature of the solute element than on its concentration. (auth)

44717 RELATIONSHIP FOR NON-CONSERVATIVE-VOLUME CREEP UNDER DIFFERENT STATES OF STRESS. Gilbert, E. R.; Straalsund, J. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Eng. Design; 12: 421-4(1970).

A relationship was developed which provides correlation of Newtonian flow (linear stress dependent creep) under different stress states during non-conservative-volume creep. Results of postirradiation creep annealing and differences between torsional and tensile in-pile relaxation experiments indicate that about $^5/_6$ of the observed tensile strain can be attributed to stress-induced isotropic swelling. (auth)

44718 U + N_2 REACTION LAYER GROWTHS. Benz, Robert; Hutchinson, W. B. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater.; 36: 135-46(Aug 1970).

Reaction layers were formed on uranium at various temperatures up to 2400°C in nitrogen (0.003 to 2.0 atm). Reaction with solid uranium was propagated by spalling and was most rapid near 800°C. Reaction with liquid uranium occurred by two parallel processes, diffusion through and fracturing of UN layers. From observed thicknesses of fracture-free layers, concentration-gradient chemical interdiffusion coefficients were calculated. Marker experiments indicated that the UN layers formed by inward diffusion of nitrogen atoms from which were deduced nitrogen self-diffusion coefficients represented by the equation $\overline{D}_N^S[cm^2/sec] = 12 \exp -(120 \pm 25)[kcal/mole]/RT$. Nitrogen self-diffusion coefficients were also deduced from estimated nitrogen activity gradients and these exhibited a dependence on nitrogen pressure. Uranium-saturated UN compositions ranged from N/U = 0.991 to 0.997 ± 0.006 at temperatures above 1600°C. Change in N/U ratio across the UN phase was 0.005 at about 1600°C. (auth)

44719 MODERATOR AND CONTROL MATERIALS. Reactor Mater.; 13: 83-91(Summer 1970).

Research and development results on Be and Be alloys are reviewed. Information is included on Be mechanical properties, power metallurgy, corrosion, and radiation effects. Data on the properties of solid hydrides such as ZrH, LiH, GdH, and hydrided Zr alloys are presented and discussed. Reviews are also included on metallic poisons, disperison-type poisons, and nonmetallic poisons. (J.R.D.)

44720 THERMODYNAMIC STABILITY OF CERTAIN INTERMETALLIC COMPOUNDS MADE FROM TRANSITION ELEMENTS. Wengert, Paul Richard. Berkeley, Calif.; Univ. of California (1969). 123p. University Microfilms Order No. 70-6258.

Thesis.

The Zr compounds of Re, Ru, Os, Rh, Ir, Pd, Pt, Ag, and Au are studied. Limits and estimates of the Gibbs free energy of formation of these compounds are determined by observing high-temperature reactions of C and ZrC with the above elements and with their Zr compounds. $ZrRh_3$, $ZrIr_3$, $ZrPd_3$, and $ZrPt_3$ exist in equilibrium with C and ZrC and have $\Delta F^\circ < -11.5$ kcal/g-atom of compound calculated at 298°K. C and ZrC exist in equilibrium with the Ru (0.75 at. % Zr), Os (≥0.06 at. % Zr), Ag (liquid, ≥0.05 at. % Zr), Au (liquid, 9.5 ± 3.5 at. % Zr phases at 1500°C. The ΔF_f° ($ZrRu_2$) is calculated from the equilibrium data to be -13.6 ± 0.9 kcal/g-atom at 1500°C and ΔF_f° ($ZrAu_4$) is calculated to be -7.93 ± 0.35 kcal/g-atom at 1000°C. The activity coefficients of Zr (γ_{Zr}) in the limit of 0% Zr are calculated from the three-phase equilibria. No ternary compounds were observed for the above systems. In the case of the C-Zr-Re system, a molar ratio of Zr to Re of 19.0 to 81.0 was found in the hcp Re phase in the presence of C and ZrC indicating that this phase extended into the ternary system; therefore, no thermodynamic information could be determined by this method for the Zr-Re binary system. The lattice parameters of the expanded hcp Re phase are determined to be: a = 2.7810 ± 0.0004Å, C = 4.4590 ± 0.0008Å. Miscellaneous properties of the binary alloys are given. Reactions of carbides, borides, and nitrides with transition elements reported by other authors are reviewed. Limits on ΔF_f° of the following compounds are calculated at 298°K: $ZrRh_3$, $ZrIr_3$, $HfRh_3$, $HfIr_3$, $ThIr_2$, $ThAu_2$, $NbPt_2$, $NbIr_3$, $NbRe_{2\pm x}$, $TaPt_2$, UIr_3, URh_3, U_2IrC_2, U_2RhC_2, and UAu_2. An appendix on the Engel and Brewer concepts of crystal structure and bonding is included. (Diss. Abstr. Int., B)

44721 ASYMMETRIC SLIP IN Mo SINGLE CRYSTALS. Lau, S. S.; Dorn, J. E. (Univ. of California, Berkeley). Phys. Status Solidi (a); 2: 825-36(16 Aug 1970).

The tensile properties of Mo single crystals in six different

orientations were investigated over the range from 20 to 550°K. The plastic behavior shows asymmetry in the critical resolved shear stress for slip on both {110} and {112} planes. At low temperatures, within the thermally activated region, slip takes place on well-defined crystallographic planes. At high temperatures in this range, however, slip takes place on irrational planes. The asymmetries associated with the yield stress and slip decrease with increasing temperature. An attempt was made to rationalize these asymmetric behaviors in terms of the modified Peierls model. This model assumes that the asymmetric slip arises from a tendency toward asymmetric arrangement of atoms in the core of the a/2 ⟨111⟩ screw dislocations. It is shown that the model is in qualitative agreement with the observed trends. (auth)

44722 FORMATION HEAT OF INTERMETALLIC COMPOUNDS: Au–Zn, Au–Cd, AND Cu–Zn IN LIQUID MERCURY. Jakuszewski, Bogdan; Grabowski, Jan Ireneusz; Partyka, Stanislaw (Univ. of Lodz, Poland). Rocz. Chem.; 44: 1025-30 (1970). (In Polish).

Thermochemical investigations on ternary systems: amalgams AuZnHg, AuCdHg, CuZnHg, and CuCdHg were carried out. Using immediate calorimetric measurements the formation heat of intermetallic compounds: Au–Zn, Au–Cd, and Cu–Zn in mercury was determined. The heat of formation for intermetallic compounds in mercury was obtained by mixing two simple amalgams. Temperature was measured using thermistore combined with an uncompensated Wheatstone bridge. It was shown, that heat of formation of intermetallic compounds of gold with zinc and gold with cadmium in mercury did not depend on proportion of metal concentration in mercury. The values for enthalpy of formation for Au–Zn compound in mercury is in good agreement with those calculated by using Van'tHoff's expression and dissociation constants of this compound in mercury, obtained by Hartman and Schölzel. (auth)

Structure and Phase Studies

Refer also to abstract 45355.

44723 (NYO–3454-33) THERMAL, STRUCTURAL AND MAGNETIC STUDIES OF METALS AND INTERMETALLIC COMPOUNDS. Annual Report, May 15, 1969–May 15, 1970. Wallace, W. E.; Craig, R. S. (Pittsburgh Univ., Pa. Dept. of Chemistry). 10 Jun 1970. Contract AT(30-1)-3454. 162p. Dep. CFSTI.

Research efforts during the period were devoted to magnetic characteristics of intermetallic compounds containing two rare earths combined with Ni, characteristics of Y–Ni–Cu systems, characteristics of ternary intermetallic compounds containing rare earths, Fe, and Co, properties of $CeNi_2$–$CeCu_2$, properties of $GdNi_2$–$GdCu_2$, rare earth ions in hexagonal fields, structure of ternary intermetallics containing rare earths, specific heats of intermetallic Mg–Cu–Zn compounds, and magnetic properties of ternary phases containing two rare earths combined with Co. Properties of intermetallic Dy–Zr–Fe and Ho–Zr–Fe compounds are also given. (J.R.D.)

44724 (UCRL–19629) ELECTRON MICROSCOPY OF SPINODAL ALLOYS. Livak, R. J.; Thomas, G. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1970. Contract W-7405-eng-48. 7p. (CONF-701003–5). Dep. CFSTI.

From 28th Meeting on Electron Microscopy Society of America, Houston, Tex.

The microstructure of spinodal copper–iron–nickel alloys was studied by electron microscopy. Microstructural changes during aging were correlated with changes in yield stress and fracture mode of the aged specimens. (G.M.C.)

44725 PHASE TRANSFORMATION OF TITANIUM AND ZIRCONIUM IN SHOCK WAVES. German, V. N.; Bakanova, A. A.; Tarasova, L. A.; Sumulov, Yu. N. Sov. Phys.-Solid State (Engl. Transl.); 12: 490-1(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 637-9(Feb 1970).

Ti and Zr samples were subjected to short-term pulsed loading by shock waves with amplitudes of 120 to 500 kbar. X-ray diffraction studies showed the new phase of Zr not to be the high-pressure ω phase, but to be a body-centered cube with a = 3.568 ± 0.005 Å. The new Ti phase was also shown to be probably bcc, with a = 3.276 Å. (D.L.C.)

44726 ASYMMETRIC DEFORMATIONS OF MOLYBDENUM SINGLE CRYSTALS. Lau, Silvanus Siu-wai. Berkeley, Calif.; Univ. of California (1969). 67p.

Thesis.

The tensile properties of Mo single crystals of six different orientations were investigated over the range from 20 to 550°K. The plastic behavior shows asymmetry in the critical resolved shear stress for slip on both {110} planes and {112} planes. At low temperatures, within the thermally activated region, slip seems to take place on well defined crystallographic planes. At high temperatures in this range, however, slip takes place on irrational planes. The asymmetries associated with yielding and slip both increase with decreasing temperature. These effects are rationalized in terms of a modified Peierls model. For the model it is assumed that the asymmetric slip arises from a tendency toward asymmetric splitting of the core of the a/2 ⟨111⟩ screw dislocation. It is shown that the model can be used to predict with reasonable accuracy the stress-temperature-strain rate-orientation relationship and the slip behavior. (Diss. Abstr. Int., B)

44727 INVESTIGATION OF THE COPPER-RICH PORTION OF THE COPPER–NIOBIUM SYSTEM. Sinibaldi, Manuel Tubino. Pittsburgh; Univ. of Pittsburgh (1969). 101p.

Thesis.

The copper–niobium system is of technical interest because of the promising economic value of high-conductivity, high-strength copper alloys. However, very little work has been done on the phase constitution of this system, and the copper-rich portion as well as the miscibility gap construction of the only phase diagram published to-date are inconsistent with the original experimental data. The phase boundaries of the copper-rich end of the copper–niobium system were re-investigated by differential thermal analysis and electromotive force measurements. The alloys were prepared by an induction melting and chill casting technique, after it was found that arc melting resulted in the formation of a niobium-rich envelope during cooling. Differential thermal analysis studies of nine alloys, ranging from 0.15 to 10 percent niobium, and heated to 1200°C, yielded data for the determination of the solidus line. The melting points of each alloy were indicated on the plotted data by a sudden sharp, vertical drop in the heating curves. These data show that the copper–niobium system is of the eutectic type with the eutectic invariant at 1067.5°C. Electromotive force measurements were obtained using a compound solid electrolyte half-cell consisting of a closed-end impervious ThO_2–Y_2O_3 tube within a similar ZrO_2–CaO tube. The data show the existence of a terminal solid solution from zero to about one percent of niobium. The results demonstrate that the current designation of the copper–niobium system as a peritectic is in error. Instead, the data show that this system is a eutectic, with the eutectic invariant at 1067.5°C and at 97 weight percent copper. In addition, it was demonstrated for the first time that the half-cell method with some modifications can be used to obtain emf data for solid alloy systems with extremely low oxygen partial pressure. (Diss. Abstr. Int., B)

44728 STUDY OF GRAIN BOUNDARIES BY FIELD ION MICROSCOPY. Bayuzick, Robert John. Nashville; Vanderbilt Univ. (1969). 153p.

Thesis.

As part of a continuing program in the nature of interfaces, studies were made of grain boundaries in tungsten and thoriated tungsten utilizing field ion microscopy. Several high angle boundaries were observed and compared with the coincidence lattice model. Two high angle boundaries forming a node with a low angle boundary were not consistent with the theory; their misorientation relationships, 33° about [35$\bar{1}$] and 24° about [241], were far removed from all coincidence lattice descriptions. The other high angle boundaries observed involved misorientations about [110] and conformed to the model. However, the results are not entirely unambiguous in that all specimens exhibit a [110] fiber texture which predetermines the axis of misorientation to be observed. In addition, the very nature of the coincident lattice model, together with the accuracy of orientational measurement, does not allow a critical test for [110] rotations. All of the high angle boundaries observed refute the coincidence lattice model from the standpoint of boundary topography. Using trace analysis on micrographs, it was found that in general the boundaries were curved on the atomic scale, i.e., individual planar segments did not persist over more than a few atom diameters. The surfaces were impossible to construct; however, an approximate representation was obtained by examining micrographs of a field evaportaion sequence involving increments of five (110) layers for a total of about 300 layers. Two other prominent features of boundary topography were seen. The first of these was the existence of fine serrations which ranged in height up to a few atom diameters. The second was the existence of ledges with which dislocations were associated. The ledge widths were of the order of ten angstroms. The low angle boundary observed was characterized by a misorientation of 7° about [110]. The dislocations comprising the boundary were easily seen and

identified through a field evaporation sequence. Dissociation reactions were evident and the entire array was rather irregular. As a necessary part of the experiments several analytical tools were derived. In particular, methods for the determination of boundary planes and dislocation directions were developed. A net corresponding to the pseudo-stereographic projection was also developed. (Diss. Abstr. Int., B)

44729 MASSIVE GRAIN GROWTH DURING AGING OF QUENCHED Zr/1.25 WT. PERCENT Cr/0.1 WT. PERCENT Fe. Rumball, W. M.; Coleman, C. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 36: 147-52(Aug 1970).

During the aging of quenched Zr/1.25 wt % Cr/0.1 wt % Fe massive α-grains formed in material which was quenched at rates calculated to be in the range of 3500 to 7500°C/s. This grain growth reduced tensile strength by about 10% and ductility by as much as 50%. The dislocation content of the quenched products varied with cooling rate and strain induced boundary migration is suggested as a possible mechanism. Methods by which this deleterious effect can be eliminated are discussed. (auth)

44730 PRECIPITATION BEHAVIOR OF THE MARTENSITE PHASE OF A ZIRCONIUM ALLOY WITH 1 WT. PERCENT VANADIUM. Borchers, H.; Koepf, H. (Institut fuer Metallurgie und Metallkunde, Munich). J. Nucl. Mater.; 36: 200-10(Aug 1970). (In German).

In contribution to the improvement of mechanical properties of zirconium alloys, the age-hardening of the martensite phase of the alloy Zr/V (1% by wt) at temperatures between 400 and 700°C was studied. These particles semi-coherent formed, which at the beginning of the precipitation were arranged in definite planes of the martensite lattices, were reduced with increasing precipitation time, at the expense of the particles in the martensite plate boundaries. The precipitates in the martensite plates were combined with hardening. The rate of precipitation was dependent on the defection density and on pre-precipitation, both of which could be determined by the quenching rate. (auth)

44731 SITE OCCUPANCY AND BUBBLE FORMATION OF HELIUM IN HIGH PURITY ALUMINUM. Cost, J. R.; Johnson, D. L. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1799. J. Nucl. Mater.; 36: 230-3(Aug 1970).

The site occupancy of helium in irradiated high-purity aluminum was determined to be substitutional from precision lattice parameter measurements. The kinetics of bubble formation was followed by measurements of both residual electrical resistance and lattice parameter. (G.M.C.)

44732 LIQUIDUS ISOTHERMS IN THE Ga–In–As SYSTEM. Panish, M. B. (Bell Telephone Labs., Inc., Murry Hill, N. J.). J. Electrochem. Soc.; 117: 1202-3(Sep 1970).

The liquidus temperatures along two cuts in the Ga–In–As ternary system were used with phase data for the boundary binary systems to plot the positions of the liquidus isotherms in that system. Isotherms of 1200° which were estimated on the basis of a quasichemical model and on the assumption of total ideality were found to be in fair agreement with the experimental curve. This degree of agreement between the positions of isotherms calculated on the basis of these two different assumptions about the thermodynamic properties of the liquid and the solid emphasizes that in the III to V systems the shapes of the isotherms are primarily determined by the differences in the free energies of formation of the binary compounds. Any model which includes this difference as a major contributor to the behavior of the system will yield isotherms in fair agreement with the true isotherms. This does not, however, imply that the model selected is a true description of the system, but merely that the shapes of the liquidus isotherms are insensitive to the model. (auth)

44733 IDENTIFICATION OF VACANCY LOOPS IN IRRADIATED TUNGSTEN. Buswell, J. T. (Berkeley Nuclear Labs., Eng.). Phil. Mag.; 22: 391-4(Aug 1970).

The character and nature of small defect clusters in irradiated tungsten have been determined by electron microscopy. It is demonstrated that advantage may be taken of the shape of the field-ion microscope specimens in determining the distribution of heavy ion damage at various depths from the surface. (auth) (UK)

44734 CRYSTAL STRUCTURE OF THE COMPOUND Zr_3Co. Kripyakevich, P. I.; Markiv, V. Ya.; Burnashova, V. V. (L'vov State Univ., Kiev. Inst. of Problems on Material Studies, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 6, 551-3(Jun 1970). (In Ukrainian).

The crystal structure of the compound Zr_3Co was determined by x-ray single crystal methods. It was found that the structure belongs to the $PuBr_3$-type (space group Cmcm = D_{2h}^{17}, 8 $Zr^{(1)}$ in 8 (f) 0 yz with y = 0.135, z = 0.057, 4 $Zr^{(2)}$ in 4 (c) 0 y1/4 with y = 0.424, 4 Co in 4 (c) with y = 0.740); a = 3.27 Å, b = 10.84 Å, c = 8.95 Å. (auth)

44735 STRUCTURE OF Ta_2D. Petrunin, V. F.; Somenkov, V. A.; Shil'shtein, S. Sh.; Chertkov, A. A. Sov. Phys.-Cryst. (Engl. Transl.); 15: 137-9(Jul-Aug 1970).
Translated from Kristallografiya; 15: 171-3(Jan-Feb 1970).

A neutron-diffraction study of the Ta_2D phase was carried out, using a more intense neutron beam than in previous investigations. The reflection intensities in the pattern are in good agreement with those observed by Wallace (J. Chem. Phys. 35: 2156(1961)). Superlattice reflections in the model of a completely ordered Ta_2D structure are discussed. The distributions of the D and metal atoms are discussed. (D.L.C.)

44736 PHASE DIAGRAMS: MATERIALS SCIENCE AND TECHNOLOGY. VOLUME II. THE USE OF PHASE DIAGRAMS IN METAL, REFRACTORY, CERAMIC, AND CEMENT TECHNOLOGY. Alper, Allen M. (ed.). Refractory Materials, A Series of Monographs. New York; Academic Press Inc. (1970). 367p. $16.00.

The use of phase diagrams in metal, refractory, ceramic, and cement technology is examined. The information is presented in chapters on phase relations in oxide systems, phase relations with microstructure in ceramics and cermets, use of phase diagrams of refractories, use of phase rule in cement chemistry, extraction metallurgy, intermediate phases in metals, sintering of ceramics and metals, metal heat treatment, and joining of metals. (J.R.D.)

44737 STUDY OF ORDERING IN THE Cu–Be beta-PHASE. Rautioaho, R.; Suoninen, E. (Univ. of Oulu, Finland). Phys. Status Solidi (a); 2: 493-6(16 Jul 1970).

The β (bcc disordered) and β' (CsCl) phases were studied in the Cu–Be system by high-temperature x ray diffraction. Closing of the miscibility gap between β and β' was confirmed. The form of the gap suggests that the system behaves according to the Landau theory, exhibiting a breakdown of a second-order ordering reaction at the top point of the gap. The degree of long-range order was also investigated as a function of the temperature in the two-phase field ($\beta + \beta'$). (auth)

44738 U–Ni–S SYSTEM. Dewally, Danys; Perrot, Pierre; Leroy, Jean-Marie; Tridot, Gabriel (Ecole Nationale Superieure de Chimie, Lille). Compt. Rend., Ser. C; 270: 1980-3(15 Jun 1970). (In French).

Studies of the reactions between the sulfides of nickel and uranium at 800°C have revealed the existence of three unknown phases: $U_{11}Ni_2S_{24}$, $U_2Ni_3S_7$, U_2NiS_4. (auth) (France)

Radiation Effects

Refer also to abstracts 44816, 44817, 45325, 45333, 46030, 46043. 46081, 46124, 46127, 46129, and 46132.

44739 (GEAP-13517) EMPIRICAL ANALYSIS OF SWELLING OF AUSTENITIC STAINLESS STEELS IN FAST REACTORS. Comprelli, F. A.; Oldberg, S.; Sandusky, D. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Sep 1969. Contract AT(04-3)-189. 70p. Dep. CFSTI.

Over the past several years, a large amount of information has been published regarding swelling in irradiated austenic steels. Measurements as high as 7% volume increase have been made at fluences up to 6.85×10^{22} n/cm^2 (E > 0.1 MeV) for temperatures during irradiation from 371 to 757°C. These data have stimulated a broad investigation into the phenomenon and the conditions of irradiation which influence it. To interpret the swelling data for design purposes, empirical expressions have been developed which describe the swelling behavior of type 304 and type 316 stainless steels as a function of fluence and temperature during irradiation. These expressions are also weighed in light of theoretical considerations and the uncertainties associated with the environment of the experiment. In addition to the primary variables of fluence and temperature during irradiation, other factors, which are thought to influence the magnitude of swelling, have been considered, including alloy composition, alloy microstructure, and stress. (auth)

44740 (JUL-653-MA) METHOD FOR SIMULATION OF THE PROCESSES OF RADIATION DAMAGE IN METALS WITH THE HELP OF AN ELECTRONIC CALCULATOR. Scholz, Alfred H. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Angewandte Mathematik). Apr 1970. 113p. (In German). Dep. CFSTI (U. S. Sales Only).

A study was made of the simulation of radiation damage in metals. An energy model similar to that of Gibson et al. was used

in the formulation, explicitly for copper, but generally applicable to other cubic face-centered metals. A computer program was used which was independent of the GRAPE program employed in previous radiation damage simulations. A detailed representation is given of the physical model and the energy balance. The approximation methods used are described accurately. Data are presented on the controls, accuracy, and reliability of the methods used. The program developed is described in detail. The evaluation and processing of the information obtained from the program is considered. Examples are given which demonstrate the functioning of the methods and program. (J.S.R.)

44741 (NRL–7095) INFLUENCE OF COMPOSITION ON THE FRACTURE TOUGHNESS OF COMMERCIAL NUCLEAR VESSEL WELDS. Steele, Lendell E. (Naval Research Lab., Washington, D. C.). 11 Mar 1970. 20p. (CONF-700812–1). Dep. CFSTI.

From 2nd Inter-American Conference on Materials Technology, Mexico City, Mex.

Weld joints of nuclear vessels are considered as potentially the weakest link in reliability. The fracture toughness of nuclear vessel welds has become the focal point for those concerned with the reliability of nuclear vessels. Irradiation studies of welds of the ASTM Type A302-B and A533-B steels, most commonly used for commercial water reactor vessels, have demonstrated several instances in which the weld metal exhibited lower fracture toughness or greater elevation of the brittle-to-ductile transition temperature than that observed for the companion base-plate and weld heat-affected-zone material. Examination of the structure and composition has led to the conclusion that composition is critical to the level of radiation-induced embrittlement. The level of copper and phosphorus contents has been shown to be especially critical to the level of embrittlement with welds having high copper (>0.20%) and phosphorus (>0.015%) showing greater embrittlement than those containing lesser amounts. These experimental observations have been verified through laboratory tests in which these constituents and other residual elements have been controlled in weldments simulating those for reactor service. The study of controlled weld composition has been extended to the welds of the higher strength ASTM Type A543 steel with even more remarkable results than those observed for the lower strength steels of current commercial reactor vessel construction. These results when applied in specifications for future reactor vessels should go far toward alleviating radiation embrittlement of reactor vessels and also provide guidance for projecting the level of fracture toughness of operating vessels at selected points in the lifetime of a vessel. (auth)

44742 (ORNL–4560, pp 88-105) MECHANICAL PROPERTIES OF ALLOYS IN REACTOR ENVIRONMENTS AND DEVELOPMENT OF LMFBR CLADDING AND STRUCTURAL MATERIALS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Samples of Type 304 stainless steel which had been irradiated to a fluence of 4×10^{22} neutrons/cm^2 (>0.1 MeV) at 370 to 800°C were examined. The density change reached a maximum at an irradiation temperature of 450 to 500°C. Dislocation structures were produced at irradiation temperatures up to 630°C, but none were produced above 770°C. With increasing irradiation temperature to about 570 to 630°C, the concentration of voids decreased and their size increased. Samples irradiated at 770 to 840°C contained cavities that we believe are He bubbles. Comparative studies of the void densities and sizes in pure metals and in alloys reveal several important differences in behavior. The results seem to support a model for alloys in which compositional changes surrounding voids reduce the local diffusion rates and limit the growth of the voids. Voids in pure metals seem to grow without bound. The importance of irradiation temperature on the property changes that occur in stainless steels has been demonstrated repeatedly. Since the maximum void size is a unique function of the irradiation temperature, it is suggested that microstructure may be a useful method for determining the irradiation temperature. (auth)

44743 THE EFFECTS OF FAST FLUX IRRADIATION ON THE MECHANICAL PROPERTIES AND DIMENSIONAL STABILITY OF STAINLESS STEEL. Claudson, T. T.; Barker, R. W.; Fish, R. L. (Battelle Northwest Lab., Richland, Wash.). Nucl. Appl. Technol.; 9: 10-23(Jul 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

Fast neutron irradiations in the EBR-II have been completed on biaxial stress-rupture, creep, and tensile specimens of AISI 304 and 316 stainless steel. Test results show that irradiations in the 480 to 650°C range to fluences of 1×10^{22} n/cm^2 (E > 0.1 MeV) substantially reduce the time dependent rupture life and ductility of these materials. Tensile ductility is also severely reduced. Bulk density measurements and electron microscopy examinations on specimens of annealed 304 from EBR-II core components and mechanical property specimens have been made for fluence levels to 7×10^{22} n/cm^2 and at temperatures in the 360 to 470°C range. Both the bulk density measurements and microscopy examinations correlate well and indicate that volume changes of 4% can be expected under these conditions. The temperature and fluence dependency for annealed 304 stainless steel has been determined and can be expressed as: $(\Delta V/V) = 10^{-48.31} \times (\phi t)^{1.71} \times 10\ [(1.549 \times 10^4/T) - (5.988 \times 10^6/T^2)]$. The mechanisms responsible for the observed degradation of mechanical properties and metal swelling are being studied. Some observations are presented. However, as yet, no adequate nucleation and growth model has been determined to enable an acceptable extrapolation of these data to goal fluence levels to be achieved in LMFBR core components or fuel pin cladding. (auth)

44744 AN ANALYSIS OF FAST NEUTRON EFFECTS ON VOID FORMATION AND CREEP IN METALS. Harkness, S. D.; Tesk, J. A.; Li, Che-yu (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 9: 24-30(Jul 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

A model has been developed for the evolution of voids and dislocation loops during fast neutron irradiation of austenitic stainless steel. The model is based on a thermodynamic approach in which void nucleation and growth rates are calculated in terms of the supersaturation of vacancies and interstitials. It is recognized that the steady-state point-defect concentrations decrease with fluence as the result of the creation of additional sinks (voids and loops). The ability to monitor both the microstructural development and the steady-state concentrations of defects allows discussion of the in-pile mechanical properties. The yield strength of austenitic stainless steel is expected to increase rapidly during irradiation at 400°C due to the effectiveness of voids and dislocation loops as obstacles to dislocation motion. Irradiation at 600°C is predicted to result in a slowly increasing yield strength. In-reactor creep behavior is discussed in terms of a climb-controlled model for a dispersion strengthened system. Radiation enhanced climb is expected to predominate at lower temperatures and stresses over the thermal climb component. Discussion of the possible effects of neutron flux and fluence on the in-pile steady-state creep rate is also included. (auth)

44745 NEW CORRELATIONS INVOLVING THE LOW-CYCLE FATIGUE AND SHORT-TERM TENSILE BEHAVIOR OF IRRADIATED AND UNIRRADIATED 304 AND 316 STAINLESS STEEL. Conway, J. B.; Berling, J. T.; Stentz, R. H. (General Electric Co., Cincinnati). Nucl. Appl. Technol.; 9: 31-9(Jul 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

Short-term tensile data have been generated using a new experimental technique which allows the true total axial strain rate to be maintained constant all the way to fracture. Tensile data at 650°C for irradiated and unirradiated specimens of AISI 304 and 316 stainless steel are presented and compared. A new relationship between low-cycle fatigue and short-term tensile behavior is discussed and applied to data for irradiated and unirradiated material. The effectiveness of this approach is shown to be excellent. This method should allow the low-cycle fatigue behavior for irradiated material to be estimated with acceptable accuracy. Hold times at peak strain have a noticeable effect on fatigue behavior as evidenced in tests at 650°C. These effects are most pronounced when hold periods are employed in only the tension portion of the cycle. An interesting correlation of hold-time data is presented based on a logarithmic plot of time to fracture versus the length of the hold period. Another important correlation involves a relationship which identifies a method for estimating hold-time effects from a knowledge of the effect of strain rate on low-cycle fatigue behavior. (auth)

44746 EFFECTS OF PREINJECTED HELIUM ON VOID FORMATION IN QUENCHED ALUMINUM. Wolfenden, A. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 36: 218–22(Aug 1970).

Rolled foils of pure aluminum were either alpha-particle bombarded or annealed in air before being quenched to introduce voids. Transmission electron microscopy was used to study the voids. The specimens that were alpha-particle bombarded before quenching were found to contain larger but fewer voids than the other

specimens. The results of the investigation are discussed in terms of the effects of helium on void nucleation. (auth)

44747 LABORATORY EXPERIMENTS TO STUDY SURFACE CONTAMINATION AND DEGRADATION OF OPTICAL COATINGS AND MATERIALS IN SIMULATED SPACE ENVIRONMENTS. Hass, G. (Army Electronics Command, Ft. Belvoir, Va.); Hunter, W. R. Appl. Opt.; 9: 2101-10(Sep 1970).

Instrumentation and techniques used for studying the effect of surface contamination on the reflectance of evaporated vacuum ultraviolet mirrors and temperature control coatings are discussed, and data on the behavior of optical materials and coatings under ultraviolet, electron, and proton irradiation are presented. (auth)

44748 EFFECT OF IRRADIATION ON THE PROPERTIES OF WELDS OF HIGH-ALLOY STEELS AND ALLOYS. Botinov, S. N.; Kazennov, Yu. I.; Agapova, N. P.; (and others). Svar. Proizv.; No. 3, 4-6(Mar 1970). (In Russian).

The effect of neutron irradiation on the short-term mechanical properties of basic metals and welds from 00Kh16N15M3B, 0Kh16N15M3B, and 0Kh20N40B austenitic steels and 1Kh132BFR ferrite–martensite steel was investigated. The mechanical properties were determined on samples cut in the longitudinal direction from argon-arc welds using an infusible electrode. The samples were irradiated in the active zone of a reactor at about 100°C. The theoretical neutron flux density was 10^{15} neutron/cm^2 · sec. Some samples received a dose of 2.8×10^{21} neutron/cm^2, while others received a dose of 4.3×10^{21} neutron/cm^2. The mechanical properties were determined on UMD-5 tensile testing machines at air temperatures of 20,350, and 650°C. (auth)

44749 RADIATION-ANNEAL HARDENING IN NIOBIUM: AN EFFECT OF POST-IRRADIATION ANNEALING ON THE YIELD STRESS. Ohr, S. M.; Tucker, R. P.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.). Phys. Status Solidi (a); 2: 559-69(16 Jul 1970).

The effect of low-temperature annealing on the yield stress of niobium following neutron irradiation was studied. The initial increase in yield stress upon irradiation was sensitive to the interstitial carbon content. A further increase in the yield stress ("radiation-anneal hardening") was observed after two-hour anneals near 150 and 300°C. When the annealing temperature was raised above 400°C, the yield stress gradually recovered toward the preirradiation value. Changes in the density and size of the radioinduced defect clusters were determined by transmission electron microscopy following post-irradiation anneals. An analysis of the observed hardening based on a dispersed barrier model and the density and size of defect clusters indicated that post-irradiation annealing strengthened the clusters as barriers to dislocation motion by as much as a factor of two. Previous resistivity and internal friction measurements have shown that interstitial oxygen and carbon in irradiated niobium migrate to the defect clusters at temperatures near 150 and 300°C, respectively. Thus, the radiation-anneal-hardening peaks at these temperatures are attributed to the trapping of oxygen and carbon, respectively, at defect clusters. There is a reduced tendency for dislocation channeling (i.e., defect cluster removal by slip dislocations) in radiation-anneal-hardened niobium, suggesting that indeed the clusters have been strengthened. (auth)

44750 VOIDS IN NICKEL IRRADIATED WITH ELECTRONS AFTER PREVIOUS ARGON ION BOMBARDMENT. Norris, D. I. R. (Central Electricity Generating Board, Berkeley, Eng.). Nature (London); 227: 830-1(22 Aug 1970).

Void formation causes dimensional instability and can be a serious problem in fast reactor fuel cladding since it can be produced in some metals by high flux neutron irradiation. Some preliminary results are reported on the production of voids in Ni by electron irradiation in the beam of a high voltage electron microscope following an initial 130kV argon ion bombardment. Such a microscope offers a convenient method for studying electron displacement damage effects. The electron bombardment was at 1 MV, with a beam current of 0.4 μA. All the Ni specimens at first developed black spots, which then grew and interacted, but no features were identifiable as voids. As exposure to the HVEM beam continued, however, a different electron irradiation damage structure was produced. A micrograph of a Ni specimen bombarded with 130 kV argon ions to 2×10^{18}/m^2 and then irradiated in the HVEM beam for 40 min. at 430°C is shown. A network of dislocation tangles and loops was produced, together with a high density of small and approximately square features, some darker and some lighter than background, and having the characteristics of small voids. The void density was 2×10^{15}/m^2 for a foil thickness of 130 nm. Calculations indicated that these features were not equilibrium bubbles resulting from the argon ion bombardment. This is stated to be the first observation of void formation by electron irradiation. (UK)

Ceramics and Cermets

Refer also to abstracts 43989, 44219, 44652, and 44653.

Corrosion and Erosion

Refer also to abstracts 43988 and 44655.

44751 (KFK-tr-321) BEHAVIOR OF A THERMALLY CONDUCTING LAYER OF BISMUTH BETWEEN THE CAN AND POWDERED CERAMIC FUEL. Kubota, T.; Takahashi, Sh.; Honda, Y.; Komine, J.; Odajima, T. Translated by Peter Buriks (Kernforschungszentrum, Karlsruhe, Ger.), from Nippon Genshiryoku Gakkaishi; 10: 678-83(1968). 11p. (In German). Dep. CFSTI (U. S. Sales Only).

A stainless steel tube with an external diameter of 20 mm and a wall thickness of 0.5 mm was covered on the inside with a 3 mm thick Bi-layer. The tube was then filled with uranium dioxide and heated electrically. Results showed that Bi does not enter the uranium phase, even at 2700°C. No reaction occurred between uranium dioxide and liquid or gaseous Bi. A UN-UC mixture also showed no reaction with liquid Bi at temperatures up to 1300°C. (H.B.G.)

Preparation and Fabrication

Refer also to abstracts 44223, 44677, 44687, and 44692.

44752 (DP-Report-152) FUEL ELEMENT PRODUCTION. Project DRAGON. Price, M. S. T. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 59p. (CONF-630103-21). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Processes for use in production of the first fuel charge for the Dragon reactor are described. Information is included on design of the production building, raw materials and components for the fuel elements, pretreatment procedures for graphite fuel tubes, and fuel fabrication. (J.R.D.)

44753 (DP-Report-215) APPLICATION OF X-RAY PROJECTION MICROSCOPY TO THE QUALITY CONTROL AND INSPECTION OF COATED PARTICLE FUELS FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Conde, J. F. G. (Atomic Energy Establishment, Winfrith (England)). Sep 1963. 47p. Dep. CFSTI.

The procedures for routine radiographic examination of coated particle Dragon fuels are described. Features of fuels observed using these procedures are discussed. Information is also included on equipment, radiographic interpretation, and particle metrology. (J.R.D.)

44754 (DP-Report-243) POWDER METALLURGY AGGLOMERATION METHOD FOR FABRICATION OF CARBIDE SPHERICAL PARTICLES. Project DRAGON. Gorle, F.; Huet, J. J. (Atomic Energy Establishment, Winfrith (England)). Nov 1963. 19p. Dep. CFSTI.

Variables which affect the process were investigated. It was found that the process is adequate for fabrication of various types of spherical particles. Research results showed that spheroidization is effected by interaction of binder with carbon in the particle. Acrylonitrile and graphite powders were found to be best for agglomeration of ThC–UC powders. (J.R.D.)

44755 (DP-Report-340) COST OF COATED PARTICLE FUEL FOR A HIGH-TEMPERATURE REACTOR PROGRAMME. Project DRAGON. Huddle, R. A. U.; Price, M. S. T.; Houdaille, M.; Popp, W. G. (Atomic Energy Establishment, Winfrith (England)). May 1965. 37p. Dep. CFSTI.

In order to indicate the areas where further experimental effort is likely to prove most effective in reducing fuel costs, an estimate based on the experience gained during the manufacture of fuel for the first charge of the Dragon Reactor Experiment has been carried out. A typical fuel specification has been selected for detailed cost analysis. It involves the fabrication of green particles by a powder metallurgy route, reaction sintering and coating with layers of pyrocarbon/silicon carbide/pyrocarbon deposited in a fluidized bed. If fueled compacts are to be employed, the coated particles are overcoated with an appropriate matrix material and pressed directly to the required shape. The

detailed cost estimate is based on feed of such a fuel in a 2,000 MW(e) reactor program. (auth)

44756 (DP-Report-356) THE MANUFACTURE OF THE FIRST CHARGE OF FUEL AND FUEL ELEMENTS FOR THE DRAGON REACTOR. Project DRAGON. Huddle, R. A. U.; Conde, J. F. G.; Price, M. S. T. (Atomic Energy Establishment, Winfrith (England)). Jun 1965. 31p. (CONF-650632-21). Dep. CFSTI.

From 7th Biennial Conference on Carbon, Cleveland.

The development of the fuel element for the First Charge of the Dragon Reactor Experiment has involved various branches of carbon technology. The chosen design of fuel element, fuel production route, and quality control methods are discussed. The porous carbide fuel particles, made by a powder metallurgy agglomeration technique, were coated with pyrolytic carbon (with or without an interlayer of silicon carbide) in fluidized bed furnaces, the resulting particles being dispersed in a resin-bonded graphite matrix. These annular fuel compacts were incorporated into fuel rods of ultra low permeability graphite which are made up into the final assembly. This involved 7 rods joined at the top by a high strength graphite block and at the bottom by a complex stainless steel subassembly which served to lead away the fission product purge into a clean-up plant. The rate controlling feature of production was the severity of the safety and criticality control. However, the extreme precautions taken have resulted in the whole manufacturing operation being completed without incident. (auth)

44757 (DP-Report-404) FIRST FABRICATION CYCLE OF Pu, ^{20}C IRRADIATION SAMPLES. Project DRAGON. Bairiot, H.; Batchelor, E.; Bomberna, G.; Gorle, F.; Hankart, L.; Looymans, H.; Peeters, L.; Sturge, R.; Vangeel, J.; Vanhellement, G. (Atomic Energy Establishment, Winfrith (England)). May 1966. 40p. Dep. CFSTI.

Plutonium containing kernels was prepared both by the Sol-Gel process and by the powder agglomeration method. Due to the high alpha contamination of the coated particles, leaching experiments were carried out; rather low decontamination factors were achieved. The results obtained during the first production cycle of Pu, C-20 Dragon fuel indicate the necessity of a small development program taking into account the specific nature of plutonium compared to uranium or thorium containing fuels. (auth)

44758 (DP-Report-414) THE FABRICATION AND IRRADIATION BEHAVIOUR OF PLUTONIUM-THORIUM CARBIDE COATED FUELS. Project DRAGON. Riley, B.; Worth, J. H. (Atomic Energy Research Establishment, Harwell (England)). Mar 1966. 49p. (AERE-R-5158). Dep. CFSTI.

The fabrication of ten irradiation capsules containing two types of kernels; $(Th_{0.84} \cdot Pu_{0.16})C_{2.4}$ and $(Th_{0.95} \cdot Pu_{0.05})C_{2.35}$ with two types of coatings. PyC_1-INTERRUPTION-PyC_2 and PyC_1-SiC-PyC_2 are described where PyC is pyrocarbon. There is strong evidence that under the reaction sintering conditions of 1900°C, 8 hours 10^{-4} mm Hg, of the oxide plus carbon mixtures, plutonium is lost as a volatile phase. After coating at temperatures between 1400 to 1600°C, and leaching in HCl, the outer surface of the particles contained high contamination levels. PyC-130 to 150×10^4 cpm/g and SiC-1.5 to 1.7×10^4 cpm/g. Warm pressing at 200°C, 1 tsi for ½ hr into a graphite crucible of a petroleum coke matrix produced a capsule whose surface contamination was below the open lab handling level. The capsules were outgassed at 1600°C, 24 hr at 10^{-4} mm Hg. In both the PyC and PyC-SiC-PyC coated particles irradiated to a maximum burn up of 26% Fifa (4.2% Fima) at temperatures up to 1400°C, irradiation damage to the coating was slight and restricted to the inner PyC layer. (auth)

44759 (LA-4293-TR) SINTERING OF BORON NITRIDE POWDERS DURING HOT PRESSING. Kuznetsova, I. G.; Poluboiarinov, D. N. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Tr. Mosk. Khim.-Tekhnol. Inst.; 50: 205-9(1966). 4p. Dep. CFSTI.

Sintering was done on boron nitride obtained by nitriding H_3BO_3 + C at 1800 to 1900°C; on identical boron nitride crushed in a ball mill for 20 hr to 10.3 m^2/g specific surface area, as determined by low-temperature nitrogen adsorption; on boron nitride obtained by nitriding H_3BO_3 + $Ca_3(PO_4)_2$ in a stream of ammonia at 900 to 1000°C; and on boron nitride obtained by nitriding finely dispersed, amorphous, spectroscopically pure boron at 1800 to 1900°C in vacuo. Density and change in specific surface area of the powders during heating were determined by low-temperature nitrogen adsorption. Powders, obtained by high-temperature nitriding, did not sinter during hot pressing, even at 1900 to 2000°C. Increasing the time at maximum temperature to 60 min at 300-kg/cm^2 pressure did not increase the density. The low-temperature boron nitride, powder, yielded a dense, strong material of 0.0 to 0.2% porosity and 3500-kg/cm^2 limit of compressive strength at room temperature. Electron-microscope and petrographic analyses showed that the ammonia nitrided powder differed sharply in structure, form, and particle size from the high-temperature powders. Low-temperature boron nitride consists of high-dispersion (0.06- to 0.3-μm crystal size), 100- to 120-m^2/g specific surface area. The high dispersibility and imperfect crystals of this material cause its recrystallization and sintering at high temperatures. (auth)

44760 (ORNL-4560, pp 3-38) DEVELOPMENT OF FAST-REACTOR OXIDE FUELS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

About 1.5 kg of microspheres containing $(U,Pu)O_2$ were prepared for loading into fuel pins for the Experimental Breeder Reactor-II (EBR-II). Result of analyses by autoradiography, electron microprobe, and γ-ray spectroscopy indicated that the concentrations of Pu in the microspheres were variable in certain of the sublots provided. This variation in Pu concentration was attributed to failure in mixing of the separately prepared UO_2 and PuO_2 sols. An additional 0.9 kg of microspheres for the EBR-II experiments was prepared. This additional material was homogeneous with respect to concentrations of Pu and U. Procedures for loading the EBR-II unencapsulated pins by the Sphere-Pac process and for obtaining the required pellet densities of 83, 88, and 93% of theoretical density were developed. Several hundred pellets of controlled density for the EBR-II 37-pin subassembly were prepared. Other activities were concerned with the fabrication of the 37-pin subassembly included qualification of raw materials, welding development, fabrication and inspection of components and equipment, and preparation of procedures. A sol-gel Sphere-Pac capsule containing $(U,Pu)O_2$ has sustained a calculated burnup of 9.2 fissions per initial actinide metal atom (FIMA) in the Engineering Test Reactor (ETR), and irradiation of the capsule is continuing at a peak heat rate of 15 kW/ft with a target burnup of 10% FIMA. Postirradiation examination of six fuel pins tested in the Transient Reactor Test Facility (TREAT) and containing sol-gel-derived $(U,Pu)O_2$ pellets and Sphere-Pac microspheres continued. Dimensional data indicate no significant changes in pin diameter except for an ovality of 0.001 to 0.005 in. in one pin and a localized ovality of 0.0015 at the bottom of another pin. Another significant result was that stereomicroscopy showed that the Sphere-Pac fuel restructured, even with the extremely short exposure experienced by the fuel in TREAT. No obvious changes occurred in the structure of the pellets used in the tests. (auth)

44761 (ORNL-4560, pp 39-61) DEVELOPMENT OF HIGH-PERFORMANCE LMFBR FUELS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

The sinterability of (U,Pu)N powders derived from an alloy was examined and compared with the behavior of powders derived from mechanical mixtures of UN and PuN. With proper pretreatment, the mechanically mixed materials can be sintered to reasonably dense structures that have microstructures and precision lattice parameters identical to those obtained from powder synthesized from a U-Pu alloy of the same U-Pu molar composition. Difficulties were apparent in synthesizing nitride powders from the alloy in that they tended to contain small concentrations of free metal after synthesis seemed to be complete. The effects of annealing on the lattice parameter of PuN and the phases derived when powders are synthesized from U-Pu alloy are under study. 185 pellets of (U,Pu)N were produced from an alloy and 45 sintered UN specimens for use in the irradiation program. (auth)

44762 (ORNL-4560, pp 218-34) DEVELOPMENT OF FUEL ELEMENT FABRICATION. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Studies of the irradiation performance of Al-base dispersion fuel elements are continuing along with an investigation of improved processing techniques for the fabrication of dispersion plates. Examination of 50% high-fired U_3O_8-Al dispersions irradiated to an average fission density of 2.24×10^{21} fissions/cm^3 is reported. Evidence of incipient failure was observed at the end of this plate, where the burnup corresponded to 2.5×10^{21} fissions/cm^3. Dispersion plates that contain the burned grade of U_3O_8 appear to be more resistant to blistering after irradiation than those that contain the high-fired grade of oxide. Also, the presence of fines increases the temperature at which the plates that contain the high-fired grade of U_3O_8 blister after irradiation. Investigations of the use of scattered and fluorescent radiation

for measuring the thickness of cladding were continued along with studies of the angle, intensity, and energy of scattered radiation. (auth)

44763 (ORNL–4560, pp 235–6) TECHNICAL ASSISTANCE IN PROCUREMENT OF FUEL ELEMENTS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Assistance was given to the Advanced Test Reactor (ATR) project by examining the problem of characterizing void volume for ATR fuel plates. A standard, general operating procedure for measuring fuel plates was written. Measurement of full-sized ATR plates of types 8 and 19 fabricated at ORNL was completed. The results from both plates agreed with the results of previous measurements of miniature plates. (auth)

44764 METHOD OF MAKING NUCLEAR FUEL BODIES. (to Gulf General Atomic Inc.). British Patent 1,201,013. 5 Aug 1970. Priority date 7 Feb 1968, United States.

A method of preparing fuel elements from fuel particles is described. The fuel casing of a selected volume is filled with fuel particles followed by a pressurized binder which occupies the interstices. The binder is then pyrolyzed to form a solid fuel body. The fuel casing can be made of graphite and the binder of a thermosetting resin. The fuel particles incorporate fission product retaining coatings. (J.R.D.)

44765 RADIATION SHIELDING. (to Chemtree Corp.). British Patent 1,200,926. 5 Aug 1970. Priority date 30 Sep 1966, United States.

Improved neutron shielding designed to also attenuate gamma radiation resulting from neutron capture is described. The material is prepared by mixing carbonates of one or more rare earths and drying to a plaster-like material. (J.R.D.)

44766 KINETICS OF THE REACTION OF UC_2 AND NITROGEN FROM 1500° TO 1700°C. Lindemer, T. B.; Leitnaker, J. M.; Allen, M. D. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc.; 53: 451–6(Aug 1970).

The kinetics of the reaction of UC_2 spheres with nitrogen was studied from 1500 to 1700°C. A metallographic method was used to determine the time-dependent conversion of UC_2 to U(C,N) and free C. The conversion appeared to be controlled by the diffusion of solid carbon in solution to sites where it could precipitate as free carbon. These sites were the surface of the sphere and particles of free carbon that existed within the original UC_2. An increased distribution of these internal sites decreased the distance for carbon diffusion and resulted in an increased rate of reaction. The UC_2 appeared to undergo a very rapid initial reaction that resulted in the uptake of 1 to 5 at. % nitrogen in the UC_2 at these temperatures. (auth)

44767 GAS PULSE IMPREGNATION OF GRAPHITE WITH CARBON. Beatty, R. L.; Kiplinger, D. V. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 488–95(Jun 1970).

A vacuum-pressure pulsing process was developed to gas-impregnate graphite with carbon. An inductively heated graphite substrate was cycled between vacuum and 20 psig butadiene for 2 to 30 hr at 750 to 950°C. The vacuum and pressure pulse periods were, respectively, 0.5 to 1 and 7.5 to 60 sec. Weight increases up to 8% were achieved in graphite of original density 1.86 g/cm^3, and helium permeabilities were reduced from greater than 10^{-2} to below 10^{-8} cm^2/sec, as required for molten-salt breeder reactor application. (auth)

44768 MARKETING AND MANUFACTURING NUCLEAR FUEL. Toye, J. M. (Canadian Westinghouse Co., Ltd., Hamilton, Ont.). Trans. Can. Inst. Mining Met.; 72: 151–2(1969).

The Canadian nuclear fuel business relates primarily to supplying fuel for Candu reactors. The product development, manufacturing and marketing activities of our nuclear fuel industry will therefore be determined by the rate of growth of the Candu nuclear reactor business. The nature of this relationship between the Canadian nuclear fuel industry and the Canadian Heavy Water Reactor program will be considered, with particular reference to the factors influencing future economic growth. (auth) (Canada)

44769 GROWTH OF UO_2 SINGLE CRYSTALS BY CLOSED-CAPSULE ZONE MELTING. Rasmussen, J. J.; Nelson, R. P. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45–1)–1830. J. Nucl. Mater.; 36: 237–40(Aug 1970).

UO_2 single crystals can be grown by closed-capsule zone melting. The material can be contained when heated above the melting point, so that there is no significant change in the O/U ratio during crystal growth. Even though the molten UO_2 is in contact with tungsten or rhenium, multiple nucleation at the capsule wall is not a problem. This technique should also be useful in growing crystals of other materials which have a high-vapor pressure or which change stoichiometry when heated to the melting point. (auth)

44770 FUEL AND FERTILE MATERIALS. Reactor Mater.; 13: 61–82(Summer 1970).

Results of research and development are reviewed on properties, fabrication, and radiation effects on UC and ThC. Data and information are also included on Pu oxides and mixed oxides concerning properties, fabrication and irradiation. Similar information is included for U, Pu, and Th nitrides. Results of research on cermet fuels are reviewed along with data on properties of metallic fuel and fertile materials. Data on fuel reactions following loss of coolant reactions are discussed along with results of basic studies on fuel materials. (J.R.D.)

44771 ULTRAFINE-GRAIN CERAMICS. Proceedings of the 15th Sagamore Army Materials Research Conference Held at Raquette Lake, New York, August 20–23, 1968. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Sagamore Army Materials Research Conference Proceedings. Syracuse, N. Y.; Syracuse University Press (1970). 413p. $17.00. (CONF-680849).

Papers presented at the conference are included on preparation of ultrafine particle size materials, characterization of ultrafine particles and ultrafine grain ceramics, processing of ultrafine grain ceramics, and behavior of ultrafine grain ceramics. (J.R.D.)

44772 PREPARATION AND CHARACTERIZATION OF SINTERED URANIUM–PLUTONIUM OXIDES. Bischoff, K.; Harrison, J. D. L.; Potter, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Brit. Ceram. Soc.; 69: 161–7(Jul 1970).

The preparation from mechanically mixed powders of sintered pellets of uranium–plutonium oxides with plutonium oxide concentrations of 10, 20, 30, and 40 wt % is described. The conditions for the preparation of dense single-phase pellets are described together with the characterization of the sintered products. The homogeneity of the pellets has been determined by electron microprobe analysis. (auth) (UK)

44773 IMPROVEMENTS IN PROCESSES FOR THE PREPARATION OF FISSILE MATERIAL CERAMICS. Francois, Bernard; Fredric, Jean-Paul; Stora, Jean-Pierre (to Commissariat a l'Energie Atomique). British Patent 1,203,969. 3 Sep 1970. Priority date 22 Dec 1966, France.

A method of preparing fissile materials using powders having a surface area of 5 to 15 m^2/g is described. The fissile material is mixed with granular metal to increase thermal conductivity and subjected to cold forming at 2 to 5 tons/cm^2 followed by sintering at 1200 to 1600°C. The fissile material is preferably UO_2. (J.R.D.)

44774 GROWTH AND MAGNETIC PROPERTIES OF V_6O_{15} SINGLE CRYSTALS. Nagasawa, Koichi (Kyoto Univ.); Bando, Yoshichika; Takada, Toshio; Horiuchi, Hiroyuki; Tokonami, Masayasu; Morimoto, Nobuo. Jap. J. Appl. Phys.; 9: 841(Jul 1970).

Single, rod-like crystals of V_6O_{15} were prepared from mixtures of VO_2 and V_6O_{11} by the chemical transport reaction method. The composition was confirmed by x-ray precession, cell volume, and V/O ratio. The magnetic susceptibility of V_6O_{15} was found to be similar to that of V_7O_{13} above 70°K; a sudden drop occurs below 70°K, probably due to a metal-to-semiconductor transition. (D.L.C.)

44775 KINETIC STUDIES OF THE PREPARATION OF URANIUM MONONITRIDE DURING THE REACTION OF URANIUM DIOXIDE WITH CARBON IN THE NITROGEN FLOW. Henke, Manfred. Neue Huette; 15: 188(Mar 1970). (In German).

Uranium mononitride in a purity of 99.95 mol% UN was achieved with a nitrogen stream of 1 atm, a partial pressure of CO of 10^{-4} atm, a carbon/oxygen ratio of 1, and a temperature range from 1350 to 2000°C. Below this temperature range U_2N_3 was formed, while above disassociation of UN occurred. Purity of the product as well as possibility to obtain granulates from 1 to 3200 μm proved that this method for UN production appears promising for technical application. (H.B.G.)

Properties Evaluations

Refer also to abstracts 44026, 44167, 44719, 44793, and 45359.

44776 (ALO–(2510)–9) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. Quarterly Progress Report No. 9, January 1, 1970–

March 31, 1970. (RCA, Harrison, N. J.). Contract AT(29-2)-2510. 55p. Dep. CFSTI.

Efforts devoted to alternate hot shoe materials are reported on Si-coated graphite specimens which were operated in air at 1000 to 1200°C for 5000 hr. Performance of the C-4 converter was evaluated for short circuits to ground. Results indicate that ZrO_2 yarn is conductive at C-4 operating temperatures. The fabrication of the C-7 converter was completed during the period. The C-1 converter completed 13,900 hr testing during the period. Test results on these converters are included along with results of performance testing of a 4-thermocouple module at constant 1000°C while varying the cold shoe temperature at 200 to 500°C. (J.R.D.)

44777 (BNL-50248) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 8, Number 2. (Brookhaven National Lab., Upton, N. Y.). Apr 1970. 70p. Dep. CFSTI.

A review is presented covering all phases of high-temperature liquid-metal technology, including materials development, corrosion and mass transfer, heat transfer, fluid dynamics, instrumentation, purification, component development, physical properties, thermodynamics, chemical analysis, and power systems. This type of information is pertinent to the fast-breeder development program and to the development of nuclear-Rankine power systems for space vehicles. (J.R.D.)

44778 (BNWL-1441) CHARACTERIZATION OF SOME UO_2 AND PuO_2 POWDERS. Barr, M. J.; Urie, M. W.; Daniel, J. L.; Mayhan, S. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. Contract AT(45-1)-1830. 39p. Dep. CFSTI.

The physical characteristics of UO_2 and PuO_2 powders as determined by B.E.T. surface area, M.S.A. particle size and distribution, and scanning electron micrographs are discussed. Powders evaluated include: two commercially produced UO_2 powders, oxalate and nitrate source PuO_2, and burned Pu metal. In addition, oxalate source PuO_2 was calcined at various temperatures to modify the particle properties. The experimental work is believed to be one of the first examples of using a scanning electron microscope to explain the problems associated with physical property measurement of fine powders. (auth)

44779 (BNWL-1458) HIGH TEMPERATURE ELECTRICAL RESISTIVITY OF REFRACTORY OXIDES: Al_2O_3. Schemmel, R. R.; Gordon, R. L.; Bates, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

Electrical insulation requirements for cables and seals in a reactor environment are becoming more stringent, and the problem of choosing an adequate insulating material for reactor instrumentation remains a difficult one. This paper summarizes a survey of reported results for Al_2O_3, emphasizing the effects of annealing history and atmosphere on the electrical resistivity. The discrepancies pointed out show the need for careful characterization of samples and for analytical measuring procedures in establishing standard techniques to determine the electrical properties of insulating materials. (auth)

44780 (DAC-63372) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 3, April-June 1969. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Jul 1969. Contract AT(45-1)-2138. 16p. Dep. CFSTI.

The safe use of radioisotope fuels requires knowledge of the capability of materials to contain the fuel. Compatibility testing of isotope-container materials combinations at or above expected use temperatures is currently being performed. Metallography was started on tungsten, tungsten-25% rhenium, and rhenium capsules containing relatively impure $^{238}PuO_{2.0}$ and $^{238}PuO_{1.8}$ after exposure at 2000°C for 1000 hours. Capsules of six different refractory alloys containing $^{238}PuO_{2.0}$ are being exposed at 1800°C and have attained approximately 1800 hours exposure at the end of the current reporting period. Testing of curium-244 sesquioxide is scheduled to begin in the first quarter of GFY 70. Preparations were made to encapsulate six plutonia-molybdenum cermets for exposure at 1800 and 2000°C up to 10,000 hours. Planning was completed to continue the testing program with a higher purity form of plutonia as it is believed that the current relatively impure plutonia results in excessive reactions caused by the impurities. (auth)

44781 (DP-Report-234) DRY FRICTION IN GAS BEARINGS AND SHAFT SEALS. Project DRAGON. Fricker, H. W. (Atomic Energy Establishment, Winfrith (England)). Oct 1963. 18p. Dep. CFSTI.

Results of tests on the frictional properties of various materials in relation to their use in seals and bearings are examined. Results are tabulated for gas bearing simulation tests, gas bearing start-stop tests, and shaft seal rubbing tests. (J.R.D.)

44782 (DP-Report-326) APPLICATION OF NON-DESTRUCTIVE TECHNIQUES IN THE QUALITY CONTROL INSPECTION AND TESTING OF FUEL MATERIALS FOR THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Conde, J. F. G.; Pointud, R.; Holliday, J.; Good, P. D. (Atomic Energy Establishment, Winfrith (England)). Mar 1965. 40p. Dep. CFSTI.

Methods employed in the inspection of Dragon fuel materials both in the development phase and subsequently in production are described. Physical methods are used for control of the chemical analysis of fuel cartridges and assessment of contamination of fuel particle coatings and particular gamma-spectrometric and alpha scintillation counting techniques are described. The general quality of coated particles is assessed and metrology of coatings performed by means of micro-radiography with the x-ray projection microscope; the procedure is outlined and typical results are presented. Fuel cartridges which consist of fuel particles in a graphite matrix are inspected for homogeneity of fuel distribution and freedom from defects by fluoroscopy and panoramic slit-scanning radiography. Color radiography is also employed to a limited extent. The various techniques are described together with illustrative examples of the results obtained. The fuel elements are fabricated almost entirely from various grades of graphite and eddy current nondestructive testing techniques are being developed to permit inspection of raw materials and finish machined components for freedom from significant defects. (auth)

44783 (DP-Report-405) STUDIES ON PYROLYTIC CARBON COATINGS ON FUEL PARTICLES. Project DRAGON. Walther, H.; Chinaglia, B.; Cocito, G.; Domenici, M.; Drago, A.; Quataert, D. (Atomic Energy Establishment, Winfrith (England)). Jan 1966. 120p. (CONF-660318-8). Dep. CFSTI.

From Dragon Contractors' Research and Development Symposium, Harwell, Eng.

Data are given on the high temperature annealing of pyrolytic carbon (PyC) coated fuel particles (in absence of irradiation) and on continuing studies on the structure of PyC coatings. Three types of coatings on UC_2 particles were treated for 300 hr at 1900°C: laminar, low deposition temperature, high density; featureless, medium deposition temperature, low density; and granular, high deposition temperature, high density. The migration of uranium into the coating was observed and measured by optical microscopy, α-counting, activation analysis, and microprobe analysis. By measurements of density spectra, c-spacings, grain sizes and porosities, variations of such structural coating properties were observed. The more important results of the annealing work in its present stage are the following. In the three sample types a uranium diffusion zone was observed near the kernel. In the first sample additional zones of high uranium concentration (~14%) were seen to be distributed all over the coating, so that this sample is considered to have completely failed. In zones, not affected by the uranium migration, a slight increase in apparent density was observed, together with decrease in c-spacing and variations of porosity. In zones, affected by uranium migration, a remarkable increase in apparent carbon density was observed, together with graphitization. No contribution of stresses to the increase of apparent density could be observed. Studies were performed with neutron diffraction and x-rays analysis to compare the structural properties of particle coatings and to relate them with the deposition temperature. The profiles of stresses and strains in isotropic and anisotropic coatings were calculated and indicate that stresses are high enough to account for coating fractures. An explanation for typical structure dependent coating failures during irradiation as spearhead attack is discussed. Regarding structure and fission gas diffusion, diffusion coefficients and activation energies were measured. The mathematical treatment of the respective diffusion problem is described. (G.M.C.)

44784 (EUR-4504) INSPECTION OF IRRADIATED MATERIALS BY MEANS OF A MICROPROBE AS ILLUSTRATED BY UO_2-Mo AND UO_2-ZIRCALOY NUCLEAR FUEL CERMETS. Giacchetti, G.; Raensch, J. (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.). 1970. 56p. (In German). Dep. CFSTI (U. S. Sales Only). EUR DM 5,10.

Knowledge of the chemico-physical behavior of the fuel elements and reactor components in the core is of crucial importance with regard to the functioning and useful life of a reactor. Although in principle all methods which were used, even for non-irradiated samples, such as physical inspection, gas analysis, x-ray spectrometry, alpha and beta autoradiography, and metallographic inspection, may be applied, microanalysis by the electron

beam microprobe appeared to be particularly suitable as a means of obtaining information on the distribution of fission products in the fuel elements, diffusion processes or corrosion phenomena in cladding materials. (auth)

44785 (LA-4415) PLUTONIUM CARBIDES. Ogard, A. E.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Mar 1970. Contract W-7405-eng-36. 6p. Dep. CFSTI.

The preparation and properties of the plutonium carbides are reviewed. The phase diagram for the C–Pu system is given. (55 references) (P.C.H.)

44786 (LA-4480) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 13. Summary of Progress from February 1–April 30, 1970. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Jul 1970. Contract W-7405-eng-36. 29p. Dep. CFSTI.

Activities in programs aimed at increased understanding of carbon and graphite properties and to improved production processes are summarized. Work is reported on Santa Maria coke, molded graphites, oriented polycrystalline graphites, carbon blacks, binders, porosity effects, phonon scattering in graphite, thermal expansion of coated fuel particles, and properties of raw materials. (J.R.D.)

44787 (MDC-G-1665) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 4, July–September 1969. Andelin, R. L.; Watrous, J. D. (McDonnell Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Oct 1969. Contract AT(45-1)-2138. 22p. Dep. CFSTI.

The safe use of radioisotope fuels requires knowledge of the capability of materials to contain the fuel. Compatibility testing of isotope-container materials combinations at or above expected use temperatures is currently being performed. Metallography was completed on refractory metal capsules containing relatively impure $^{238}PuO_{2.0}$ and $^{238}PuO_{1.8}$ after exposure at 2000°C for 1000 hours. Most of the metallography was also completed on refractory metal capsules containing the same $PuO_{2.0}$ after exposure at 1800°C for 2000 hours. Fifteen capsules containing a higher purity plutonia were fabricated. Twelve are being exposed at 1800°C. The remaining three are awaiting receipt of $PuO_{1.8}$ from Mound Laboratory to provide comparative data. Plans were completed and preparations are underway to initiate testing of cerium-244 sesquioxide early in the next quarter. Six plutonia-molybdenum cermets were encapsulated. One capsule at each of two temperatures, 1800 and 2000°C, attained 1000 hours exposure and was removed for examination. The remaining four capsules will continue exposure to 5000 or 10,000 hours. (auth)

44788 (NBS-SPEC. PUBL-303) MECHANICAL AND THERMAL PROPERTIES OF CERAMICS. Proceedings of a Symposium Held at Gaithersburg, Maryland, April 1-2, 1968. Wachtman, J. B. Jr. (ed.) (National Bureau of Standards, Washington, D. C.). May 1969. 276p. (CONF-680472). GPO $4.25.

The proceedings of the Symposium on Mechanical and Thermal Properties of Ceramics, held at the National Bureau of Standards in Gaithersburg, Maryland, on April 1 to 2, 1968, are presented. The symposium was cosponsored by the American Ceramic Society, the American Society for Testing and Materials, and the National Bureau of Standards. Attention was concentrated on properties primarily of structural and/or high temperature use including melting points, thermal expansion, thermal conductivity, thermal radiation properties, elasticity, viscoelasticity, inelastic deformation, and fracture. The dependence of these properties upon composition and microstructure was surveyed and the importance of controlling these features of character to ensure reliability of ceramics was emphasized. The procedures by which American ceramists formulate standards and specifications to assist in ensuring reliability were summarized. (auth)

44789 (NP-9556) ELASTIC PROPERTIES OF GRAPHITE. Project DRAGON. Bell, J. F. W.; Hub, D.; Smith, S. G. (Royal Naval Coll., Greenwich (England)). Oct. 1960. 19p. (DP-Report-5). Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

The measurement of the velocity of longitudinal and torsional waves in a solid rod enables the Young's and rigidity moduli to be determined. Rods out in various directions from a single crystal can give all the elastic constants of the material. These can be correlated directly with crystal structure. In an isotropic material such as glass or fused quartz the two velocities give a complete description of the material. In a polycrystalline material, the velocity depends on the grain orientation as well as the crystalline properties. (auth)

44790 (NP-tr-1919) THERMOELECTRIC POWER OF CUBIC STABILISED ZIRCONIA BETWEEN OXYGEN ELECTRODES. Fischer, W. Translated by P. A. Roos for BHP Central Research Labs., Shortland, Australia, from Z. Naturforsch.; 22a: 1575-81(1967). 12p. Dep. CFSTI (U. S. Sales Only).

The thermoelectric power $\Delta\phi/\Delta T$ [mV/degree] of cells of the type $O_2|_T$ stabilized zirconia $|_{T+\Delta T}\ O_2$ has been determined as a function of oxygen pressure ρ [torr] in the temperature range $960°K \leq T \leq 1310°K$. The experimental results can be described by the equations $-\Delta\phi/\Delta T = 0.492 + 0.0220\ \ln(159/\rho)$ for $(ZrO_2)_{0.88}(CaO)_{0.12}$; $-\Delta\phi/\Delta T = 0.460 + 0.0219\ \ln(159/\rho)$ for $(ZrO_2)_{0.91}(Y_2O_3)_{0.09}$. The change of $\Delta\phi/\Delta T$ with oxygen partial pressure corresponds to the change of partial molar entropy of O_2. The heats of transfer of oxygen ions are estimated from experimental results and thermodynamic data. From the negative sign of the heat of transfer it is concluded that oxygen ions migrate by a vacancy mechanism, which has been established also by experiments by other authors. (auth) (Australia)

44791 (ORNL-4560, pp 165-72) DEVELOPMENT OF URANIUM MONONITRIDE FUELS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

The middle fuel pin of capsule UN-3 failed after 5800 hr of operation at a cladding-surface temperature of 1370°C. Several short cracks were visible in the cladding over the fueled region of the pin. Visual examination and dye penetrant tests established that the claddings of the top and bottom fueled pins remained sound during the irradiation test. Metallographic examination of the failed (middle) pin showed that the fractures in the T-111 cladding (W lined) were primarily intergranular. These fractures are preceded by spherical voids, the nature of which is not yet known. Intergranular separations that originated at the inner surface and extended through half the wall thickness were also present in the unfailed region of the cladding. The electron microprobe analysis showed no evidence of U in either the T-111 cladding or the W lining. The top and bottom fuel pins were examined by neutron radiography; the length of the fuel column of each pin had increased by 2.3% during irradiation. The pellet interfaces were clearly shown for the top pin, but the fuel column of the bottom pin appeared to be a continuous body. (auth)

44792 (RFP-Trans-67) SPECIFIC HEAT OF UN, UC, AND UO_2. Affortit, C. Translated for Dow Chemical Co., Golden, Colo., Rocky Flats Div., from High Temp. -High Pressures; 1: 27-33(1969). 12p. (CONF-681116-3). Dep. CFSTI.

From Conference on the Thermal Properties of Solids at High Temperatures, Baden-Baden, Germany.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 48550.

44793 (UCRL-72496) CARBON ADSORBER FIRE EXTINGUISHMENT TESTS. Murrow, J. L. (California Univ., Livermore, Lawrence Radiation Lab.). 14 Jul 1970. 9p. (CONF-700816-1). Dep. CFSTI.

From 11th AEC Air Cleaning Conference, Richland, Wash.

Activated-carbon adsorbers in air-cleaning systems should be protected from fire. However, as they can ignite under unusual conditions, an adequate extinguishing system should be installed ready for use. Available systems are examined. The Savannah River-style cell (24 × 24 × 12 inches), containing approximately 60 pounds of 6-14 mesh carbon, was used for these tests. Single-head spray nozzles and arrays delivering up to 36 gallons per minute (gpm) at operating pressures to 150 psig, with patterns from fog to solid cone were tried using plain water and water with wetting agent. Under the conditions of this test, water sprays did not extinguish the fire as long as air continued to flow. Liquid nitrogen was used successfully as an extinguishing agent under the same conditions. The rate of application to a single adsorber was 20 liters per minute for seven minutes. (auth)

44794 STRESS-RUPTURE PARAMETERS FOR THE REFRACTORY METALS. Conway, J. B. (General Electric Co., Cincinnati). pp 175-98 of Time-Temperature Parameters for Creep-Rupture Analysis. Metals Park, Ohio; American Society for Metals (1968).

From Time-Temperature Parameters: Methods and Applications for Creep Rupture Data I and II of the Materials Engineering Congress, Detroit, Mich. See CONF-681081.

Recent studies have identified the creep-rupture behavior of various refractory metals to temperatures as high as 3000°C. Data have been generated for W, Re, Mo, Ta, and Nb as well as for W-25Re, Mo-50Re, and Ta-10W. These results have been used in some fairly extensive correlations based on the Larson–Miller, Dorn, and Manson–Haferd parameters. In a detailed study of the W, Mo, and W-25Re data in the temperature range 1200 to 3000°C, the Manson–Haferd parameter was found to yield the most effective representation of the stress-rupture

data. In another correlation based on the Larson–Miller parameter, homologous temperatures were employed to show identical correlations for the tungsten and molybdenum stress-rupture data. Using optimization procedures Larson–Miller constants were calculated for various refractory metals and refractory metal alloys. These constants were found to vary from 5.7 for a ternary W–Re–Mo alloy to about 10 for Ta-10W and about 20 for Mo-TZM. A summary plot is presented to provide a comparison of the parameter data for all the refractory metals and refractory metal alloys involved in this study. Also included are Garofalo-type correlations in which the Larson–Miller and Dorn parameters for several refractory metals are expressed as hyperbolic sine functions of the stress. (auth)

44795 STRESS OF ELECTROLESS NICKEL DEPOSITS ON BERYLLIUM. Parker, K.; Shah, H. (General American Transportation Corp., Niles, Ill.). J. Electrochem. Soc.; 117: 1091-4 (Aug 1970).

The residual stress of electroless nickel coatings on one side of 0.01 in. beryllium strips was determined by bow deformation measurements. Different plating conditions can produce either a tensile or compressive stress. The parameters controlling stress are those which determine the phosphorus content of the deposit, of which pH is the most important. The stress increased in the negative direction with increase in phosphorus content of the deposit. As-plated 4 mil coatings containing more than 8.5% phosphorus were compressively stressed, while those with lower phosphorus content were in tensile stress. Contraction during annealing decreased the compressive and increased the tensile stress of the plate. With close control of the plating parameters, reproducible, essentially stress-free electroless nickel coatings can be plated on critical optical beryllium surfaces such as aerospace mirrors. (auth)

44796 THERMAL EXPANSION OF $^{238}PuO_2$ PLASMA-FORMED MICROSPHERES. Desando, R. J.; Wyder, W. C.; Eckstein, R. R.; Amos, W. R. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)GEN-53. J. Nucl. Mater.; 36: 241-3 (Aug 1970).

Coefficients of thermal expansion of plasma-formed $^{238}PuO_2$ microspheres were determined for the temperature interval of 14 to 1505°C. (G.M.C.)

44797 CONSIDERATION ON THE IDEALITY OF UC–UN SOLID SOLUTIONS. Katsura, M.; Naoumidis, A.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). J. Nucl. Mater.; 36: 169-79(Aug 1970).

The monocarbides and mononitrides of uranium and plutonium as well as their solid solutions could obtain certain importance as fuel for high-power reactors. From the thermochemical point of view the question whether the mixed carbonitride crystal shows ideal, regular, or abnormal behavior is of decisive importance. Published data on measurements of equilibrium between UC–UN solid solutions and nitrogen, carbon, and uranium are studied critically with the aid of a new method of calculation. The advantage of this method is that it enables the enthalpy of mixing to be determined as a function of the temperature and the solid solution composition directly from the relevant $UC_{1-x}N_x$ measurement data, instead of those relating to the pure UC and UN components. The ideal behavior of the solid solution series on the basis of molecular volumes, which are calculated from the published data, is also discussed. Both theoretical considerations lead to the conclusion that the $UC_{1-x}N_x$ solid solutions do not show ideal behavior. (auth)

44798 ELLIPSOIDAL YIELD FUNCTION FOR MATERIALS THAT CAN BOTH DILATE AND COMPACT INELASTICALLY. Merkel, J. G. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design; 12: 425-51(1970).

The inelastic deformation of most porous materials produces plastic volume changes, a phenomenon that does not occur in the case of most metals. These plastic volume changes may be of either sign, depending on the state of stress. The inelastic deformation of some porous materials can be approximately described by means of an ellipsoidal yield function. The equations for an ellipsoidal yield function are derived, initially for the case of transverse isotropy, isotropic strain hardening, and principal axes coinciding with the axes of anisotropy. These equations are applied to a nuclear grade graphite, EGCR-type AGOT graphite. An example problem is solved concerning the thermal loading of a graphite fuel sleeve. Applications of the ellipsoidal yield function to creep analysis and to concrete, are discussed. The shear stress terms in the ellipsoidal yield function are derived to make possible a more general application of the analysis. (auth)

44799 IN-PILE RELEASE OF FISSION GAS FROM GRAPHITE. Kamemoto, Y.; Shiba, K.; Handa, M.; Yamagishi, S.; Fukuda, T.; Takahashi, Y.; Tanifuji, T.; Omori, S. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 36: 153-60(Aug 1970).

In-pile release of fission krypton, xenon, and iodine from graphite was measured and the release mechanism is discussed in detail compared with the data of post-irradiation experiments. No temperature-independent release of fission gases and iodine was observed in the temperature range from 100 to 640°C. After reactor shutdown with the specimen temperature constant, only xenon was released from the specimen and not krypton and iodine. To explain this phenomenon, a hypothesis is proposed that fission gas releases are induced by β-decay of precursor halogens trapped in defects in the specimen. By the hypothesis, the release behavior of fission gases and iodine can be explained satisfactorily. (auth)

44800 MIGRATION VELOCITIES OF BUBBLE-DEFECT CONFIGURATIONS IN NUCLEAR FUELS. Weeks, R. W.; Scattergood, R. O.; Pati, S. R. (Argonne National Lab., Ill.). J. Nucl. Mater.; 36: 223-9(Aug 1970).

When a bubble, pinned on either a dislocation or a grain boundary, reaches the critical size for continued migration, it can create either a trailing dipole or a tube of grain boundary through continued interaction with the pinning defect. The continued interaction significantly reduced the migration velocities of bubbles with less than about twice the critical radius. The velocities of spherical bubbles migrating under typical UO_2 and UC fuel-element conditions are presented. The results indicate that while volume diffusion plays an insignificant role for bubble migration in UO_2, it is the dominant mechanism in UC. For bubble migration in UO_2, results are presented for both spherical and lenticular bubbles. The lenticular shape results in somewhat higher migration velocities. (auth)

44801 CHARACTERIZATION OF POROUS MEDIA IN TERMS OF THEIR GAS TRANSMISSION PROPERTIES. Creutz, E. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng.; 41: 443-5(Sep 1970).

The applicability of a given equation which permits calculation of the porosity of such diverse materials as sintered metal powders, graphites, and packed beds of rings and spheres from measurements of gas flow through the media is discussed. Experimental data on helium flow through graphites and the results in terms of average pore sizes and effective numbers of pores found by this method are presented. (L.C.L.)

44802 ELECTRIC CONDUCTIVITY OF $NaF–ZrF_4–ZrO_2$ MIXTURES. Fontana, A.; Winand, R. (Univ. Libre, Brussels). J. Nucl. Mater.; 35: 73-81(Apr 1970). (In French).

A method of measurement associated with a boron nitride conductivity cell was developed with the aim of determining the electrical conductivity of molten fluorides. Because of the very small variation of resistance with frequency in the frequency range employed, and the very low conductivity of the empty cell, it was found possible to determine the specific conductivity of various mixtures in the $NaF–ZrF_4–ZrO_2$ system. At 1050°C, the specific conductivity of $NaF–ZrF_4$ mixtures fell measurably as the ZrF_4 content was increased from 0 to 25 mole %. Moreover, the conductivity was very little affected when ZrO_2 was added to $NaF–ZrF_4$ mixtures containing between 15 and 25 mole % ZrF_4. The specific conductivity of two compositions was determined as a function of temperature between 850 and 1050°C. (auth)

44803 HOT-PRESSING OF ZIRCONIUM DIBORIDE–MOLYBDENUM DISILICIDE MIXTURES. Kinoshita, Makoto; Kose, Saburo; Hamano, Yoshiteru (Government Industrial Research Inst., Osaka). Osaka Kogyo Gijutsu Shikenjo Kiho; 21: 97-108(Jun 1970). (In Japanese).

Powder mixtures of zirconium diboride and molybdenum disilicide were hot-pressed at 1500 to 2200°C in graphite dies under a pressure of 200 kg/cm^2 in order to improve density and oxidation resistance properties. Pressure was applied throughout the experiment and shrinkage of the compact was measured by a dilatometric method during hot-pressing at the temperatures below 2000°C. Final density was measured and density change of the compact during hot-pressing was calculated. Microstructures were also observed with microscope and electron microprobe. The compacts were heated in air at 860 to 1600°C and weight changes were measured to estimate the oxidation resistance of the compacts. Densification of zirconium boride was strongly accelerated by addition of small amount of molybdenum silicide. No other compounds except zirconium boride and molybdenum silicide were detected in the compacts by x-ray diffraction. Wetting of molybdenum silicide to zirconium boride was considered to be good by observation of the microstructures. When the densification data were processed with Murray's equation for hot-

pressing ceramics based on plastic flow mechanism, fairly good linearities were observed in the relations between log $(1-\rho)$ and t except for the beginning. From these relations, viscosities of the compacts were calculated and it was found that the viscosity decreased with increasing content of molybdenum silicide. The densification data were also processed with the rate equations based on stress enhanced diffusion mechanism. It was found that there were two steps in the densification process. First step of the densification was considered to be a deforming process of the particles at the contact area between them. This step corresponded with the early period in Murray's relations. Although the second step which corresponded with the linear period in Murray's relations was not considered to be either plastic flow or stress enhanced diffusion mechanism, this step was considered to be a diffusion process. For the compacts containing molybdenum silicide, these steps were not able to be distinguished clearly. The compacts showed good oxidation resistance with increasing content of molybdenum silicide. (auth) (Japan)

44804 MICROPOROSITY ANALYSIS ON ZIRCONIA-BASE CERAMICS BY THE ARGON ADSORPTION METHOD. I. DETERMINATION OF THE ARGON T ISOTHERM. Wagner, Vittoriano; Pizzini, Sergio. Ann. Chim. (Rome); 60: 198-207(Mar 1970).

Standard t isotherms for different samples of stabilized zirconia were obtained with the argon adsorption method at −196°C. Results may be favorably compared with those obtained with nitrogen on the same material and on TiO_2 in the anatase modification. Results are moreover discussed in terms of the influence of the surface state on the adsorptive potential parameters ϵ_0 and r. (auth)

Structure and Phase Studies

Refer also to abstracts 43990, 44715, 44736, 44738, and 45355.

44805 STRUCTUE AND MAGNETIC PROPERTIES OF THE OXYGEN–PRASEODYMIUM COMPOUNDS. Kern, Francois; Perakis, Nicolas (Strasbourg Univ.). Compt. Rend., Ser. B; 270: 1593-6(22 Jun 1970). (In French).

The physical and magnetic properties of the various praseodymium–oxygen compounds and their structures were studied. (tr-auth) (France)

44806 CHARACTERIZATION OF MIXED URANIUM ANTIMONY OXIDES $USbO_5$ AND USb_3O_{10}. Aykan, Kamran (E. I. du Pont de Nemours and Co., Gibbstown, N. J.); Sleight, Arthur W. J. Amer. Ceram. Soc.; 53: 427-31(Aug 1970).

The system U–Sb–O was examined in air up to 1000°C for ternary compounds. The products were characterized by chemical analysis, density determinations, TGA, x-ray diffraction techniques, and magnetic measurements. The ternary compounds found were $USbO_5$ and USb_3O_{10}. All cations are pentavalent in these new compounds, which are crystallographically related to α-UO_3 and U_3O_8. (auth)

44807 PHASE EQUILIBRIUM STUDIES IN THE SYSTEM Na_2O–NbO_2. Ball, M. C. (Univ. of Tech., Loughborough, Eng.). Trans. Brit. Ceram. Soc.; 69: 157-9(Jul 1970).

Equilibria in the system have been studied by high-temperature microscopy. The system shows simple compound formation at ratios Na_2O: NbO_2 = 2:1 (Na_4NbO_4) and 1:1 (Na_2NbO_3). These compounds melt congruently at 1240 and at 1720°C respectively. Provisional x-ray diffraction data for them are given. (auth) (UK)

44808 DIAGRAM OF PHASE EQUILIBRIUM OF THE SILICON–MOLYBDENUM SYSTEM. Svechnikov, V. M.; Kocherzhinskii, Yu. O.; Yupko, L. M. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 6, 553-8(Jun 1970). (In Ukrainian).

A complete diagram of phase equilibrium for the silicon–molybdenum system was constructed by differential thermal, x-ray, and microscopic analyses methods. The following chemical compounds: Mo_3Si (incongruent melting at 2025° ± 20°C); Mo_5Si_3 ($T_{melt.}$ = 2180° ± 20°C); $MoSi_2$ ($T_{melt.}$ = 2020° ± 20°C, the polymorphic transformation in the temperature range of 1850° to 1900°C) are formed in the system. Their crystalline structures were determined. There were three eutectic equilibria: L ⇌ Mo_3Si + Mo_5Si_3 at 2020°C + 20°C and 26.4 at.% Si; L ⇌ Mo_5Si_3 + β = $MoSi_2$ at 1900° ± 20°C and 54 at.% Si and L ⇌ $MoSi_2$ + Si at 1400° ± 10°C and 98.5% Si; two peritectic equilibria: Mo + L ⇌ Mo_3Si at 2025° + 20°C and β = $MoSi_2$ + L ⇌ α = $MoSi_2$ at 1900° ± 20°C and one eutectoid equilibrium β = $MoSi_2$ ⇌ Mo_5Si_3 + α = $MoSi_2$ at 1850° ± 20°C in this system. (auth)

44809 REAL STRUCTURE OF THE HIGHER CARBIDE OF VANADIUM. Arbuzov, M. P.; Fak, V. G.; Khaenko, B. V. (Inst. of Materials Science Problems, Kiev). Sov. Phys.-Cryst. (Engl. Transl.); 15: 164-6(Jul-Aug 1970).

Translated from Kristallografiya; 15: 196-9(Jan-Feb 1970).

X-ray powder diffraction studies were carried out on $VC_{0.88}$. The strong reflections correspond to those characteristic of a NaCl structure, and they can be indexed to a cubic cell with a = 8.334 ± 0.001 Å. Calculations performed with a NaCl structure having one sublattice filled by V and the other by C and vacancies agreed well with experiment. The most probable space groups are $P4_132(P4_332)$. Structure factors for the various reflections are discussed. The results are compared with those of other investigators. (D.L.C.)

44810 ETCHING OF DISLOCATIONS IN NIOBIUM CARBIDE. Turchin, V. N.; Rymashevskii, G. A. Sov. Phys.-Cryst. (Engl. Transl.); 15: 160-1(Jul-Aug 1970).

Translated from Kristallografiya; 15: 193-4(Jan-Feb 1970).

Etch pits were produced on polycrystalline NbC specimens under the following conditions: for cleavage faces by etching in HNO_3–HF at 20°C for 30 to 60 sec, and for thin sections by electropolishing in H_2SO_4–HNO_3–HF at 30 V and 0.8 to 1.0 A/mm^2 and subsequent etching. The etch pits, of pyramidal form, appeared only on grains with orientation close to (100). The characteristics of the etch pits show that they are associated with dislocations. (D.L.C.)

44811 HIGH-TEMPERATURE RADIOGRAPHIC INVESTIGATION OF URANIUM TRIOXIDE. Bessonov, A. F. Sov. Phys.-Cryst. (Engl. Transl.); 15: 48-52(Jul-Aug 1970).

Translated from Kristallografiya; 15: 62-7(Jan-Feb 1970).

Dissociation processes of uranium oxides are considered in more detail. A qualitative description is given of the kinetics of the phase transitions in the uranium trioxide–uranium dioxide systems. In the experimental investigation, a new apparatus for high-temperature x-ray diffraction was employed. Comparing the transition schemes of the various modifications of uranium trioxide, one can arrange the latter according to their degree of thermal stability in the sequence: γ-UO_3; α-UO_3; amorphous UO_3. (auth)

44812 DEFORMATION TWINNING OF V_2O_5 DURING CHEMICAL REDUCTION. Hyde, B. G.; Tilley, R. J. D. (Univ. of Western Australia, Nedlands). Phys. Status Solidi (a); 2: 749-56(16 Aug 1970).

Transmission electron microscopy revealed deformation twinning of vanadium pentoxide in partly reduced thin crystals. The twinning elements, determined from selected area diffraction patterns and micrographs, are K_1 = (310), K_2 = ($\bar{3}$10), η_1 = [1$\bar{3}$0], η_2 = [130]. The relation between these twinning elements and the lattice strain introduced by the reduced oxides is discussed. (auth)

Radiation Effects

Refer also to abstracts 45997, 46030, 46043, 46081, 46127, 46129, 46130, and 46132–46134.

44813 (DP-Report-254) FINAL REPORT ON RADIATION DAMAGE IN GRAPHITE (CON/WIN/51099). Project DRAGON. Sublet, P. (Battelle Inst., Geneva). Nov 1963. 75p. Dep. CFSTI.

Includes Appendix: ELECTRON MICROSCOPE OBSERVATIONS OF IRRADIATED GRAPHITE SINGLE CRYSTALS by W. Bollmann and G. R. Hennig (Argonne National Lab., Ill.). For Atomic Energy Establishment, Winfrith, Eng.

Results of ion bombardment tests on graphite replicas are reported and illustrated. Other research is reported on the effects of fast neutrons on graphite single crystals as compared with specimens bombarded using electrons, carbon ions, and fission fragments. Formation of interstitials and clustered vacancies were found in most samples. (J.R.D.)

44814 (DP-Report-351) EXPERIMENTS ON THE IRRADIATION OF GRAPHITE AT HIGH TEMPERATURES. Project DRAGON. Blackstone, R.; Sens, P.; Voice, E. H. (Atomic Energy Establishment, Winfrith (England)). Jun 1965. 40p. (CONF-650632–19). Dep. CFSTI.

From 7th Biennial Conference on Carbon, Cleveland.

Three different graphites were irradiated at 600 to 1350°C. These materials were a fine grain low permeability graphite containing carbon black, British Pile Grade A graphite, and a fine grain graphite not containing carbon black. Dimensional changes induced by irradiation were measured together with electrical and

thermal conductivity, thermal expansion, and Young's modulus. Irradiation induced contraction was observed at all temperatures up to the doses so far achieved, being least for P.G.A. and greatest for the graphite containing carbon black. In all cases, however, the rate of shrinkage showed a marked acceleration with increasing irradiation temperatures above 900°C. In contrast to this, changes in electrical and thermal conductivity became less marked with the increasing temperatures of irradiation and were less severe in the case of the graphite containing carbon black. These effects are discussed in the light of current hypotheses relating to the mechanism of irradiation damage in graphite. (auth)

44815 (GA–9973) HIGH-TEMPERATURE IRRADIATION BEHAVIOR OF PRODUCTION-GRADE NUCLEAR GRAPHITES. Engle, G. B.; Pitner, A. L. (Gulf General Atomic, Inc., San Diego, Calif.). 10 Jul 1970. Contracts AT(04-3)-167; AT(45-1)-1830. 30p. Dep. CFSTI.

A number of production-grade needle-coke and Gilsonite graphites were irradiated at 600 to 1280°C to maximum fluences of about 13×10^{21} n/cm^2 (E > 0.18 MeV). The needle-coke graphites behaved similarly and showed marked anisotropy in dimensional changes. At temperatures from 900 to 1280°C, they contracted in the perpendicular direction to a maximum shrinkage of about 1.5% at an exposure of 3 to 5×10^{21} n/cm^2, and then expanded upon further irradiation. In the parallel direction, they contracted rapidly with irradiation to ~10% shrinkage after fluences of 8 to 10×10^{21} n/cm^2, and then the contraction rate slowed. In contrast, the Gilsonite material showed near-isotropic behavior in dimensional changes when irradiated at 1000 to 1250°C to a fluence of 11×10^{21} n/cm^2. No differences in dimensional changes were observed between edge-cut and center-cut specimens from an 18-in.-diameter production log of needle-coke graphite. Thermal expansivity of a needle-coke graphite irradiated at 900 to 1000°C increased by a factor of 1.7 after the exposure exceeded the point where volumetric expansion becomes evident (~5×10^{21} n/cm^2). Thermal conductivity (measured at the temperature of irradiation) decreased rapidly at low fluences and ranged from 0.04 to 0.08 cal/cm-sec-°C (initial value ranged from 0.09 to 0.15) after irradiation to 1.7 to 6.0×10^{21} n/cm^2 at 500 to 1000°C. (auth)

44816 (ORNL–4560, pp 62-6) EFFECT OF POWER CYCLING ON LMFBR FUEL-CLADDING BEHAVIOR. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Data on liquid-metal-cooled fast breeder reactor (LMFBR) conditions is limited and for this reason two irradiation experiments were designed for near-term application to the Fast Flux Test Reactor (FTR). These will be used to investigate whether schemes of fuel management that involve significant power increases will be limited by mechanical interactions of fuel and cladding during power cycling and whether power cycling is of concern when the fuel element is designed to maximize these interactions. (auth)

44817 (ORNL–4560, pp 67-87) LMFBR FUEL ELEMENT DESIGN AND MODEL DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

The models used for fuel swelling and release of fission gas in the FMØDEL code were normalized and compared with experimental data for $(U,Pu)O_2$ fuel pins. Light microscopy, conventional replica electron microscopy, and scanning electron microscopy were used to characterize the microstructure and the size distribution and location of bubbles of fission gas in a low-burnup Sphere-Pac $(U,Pu)O_2$ fuel pin. Parametric calculations were performed with the FMØDEL code to investigate the effects of recent correlations for cladding swelling on the cladding stress-strain distribution and diametral expansion of a typical liquid-metal-cooled fast breeder reactor (LMFBR) fuel pin. A review of the physical properties of Type 316 stainless steel was completed. A subsequent section on mechanical properties is in progress, and the part on tensile properties is nearly completed. Tensile yield data on type 316 stainless steel tubing were summarized. Creep equations for the British cold-worked modified type 316 stainless steel were suggested for use in modeling studies. Creep curves were produced for annealed type 316 stainless steel to investigate whether significant recovery occurs following stress reductions. No such effect was observed; however, additional experiments are planned with LMFBR-grade tubing. (auth)

44818 (ORNL–4560, pp 143-62) DEVELOPMENT OF FAST-REACTOR NEUTRON-ABSORBER MATERIALS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Structural changes in boron carbide during annealing were examined. Adding B to a boron carbide powder to raise the ratio of B: C from 3.6 to 5.0 before annealing eliminated void formation during the heat treatment at 1500 and 2000°C. Adding C to lower the ratio of B: C from 3.6 to 3 increased the volume of voids. The size of the voids was larger at 2000°C than at 1500°C. A technique for producing Debye-Scherrer x-ray patterns of irradiated boron carbide were refined. Free graphite present in the unirradiated samples was not detectable on the x-ray patterns of the irradiated sample. Boron carbide powders with a ratio of B: C of 3.6 were irradiated at 350°C in the Oak Ridge Research Reactor (ORR) to measured burnups of 6.6 to 9.4% ^{10}B atoms. Helium release for all samples was between 5.0 and 5.8%. (auth)

44819 (ORNL–4560, pp 198-9) FAST-NEUTRON IRRADIATION EFFECTS ON ELECTRICAL INSULATORS. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

An assembly containing four advanced insulator materials was inserted into the Experimental Breeder Reactor-II (EBR-II) for irradiation at 400 and 800°C, and the irradiation of a low-temperature (below 150°C) assembly containing three of these materials was completed in the Engineering Test Reactor (ETR). The purpose of these irradiations is to determine whether any of these advanced materials is more stable than polycrystalline alumina in fast fluxes. An assembly containing bilayers and trilayers was irradiated in the ETR, and another assembly was inserted into the EBR-II. (auth)

44820 (ORNL–4560, pp 215-17) FISSION-GAS RELEASE AND PHYSICAL PROPERTIES OF FUEL MATERIALS DURING IRRADIATION. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

Data for the thermal diffusivity of UO_2 during irradiation was processed by means of a computer program to obtain values for thermal conductivity. The irradiation of the sol-gel $(U,Pu)O_2$ was completed. These specimens begin to release bursts of fission gas, characteristic of breakaway release, after 1.7% heavy-metal burnup. (auth)

44821 (ORNL–4560, pp 237-8) BEHAVIOR OF REFRACTORY MATERIALS UNDER IRRADIATION. (Oak Ridge National Lab., Tenn.).

From fuels and materials development program quarterly progress report for period ending March 31, 1970.

A long-term, low-temperature (below 150°C) assembly containing carbides of Ti, Zr, Ta, Nb, and W was irradiated in the Engineering Test Reactor (ETR). The results are expected to be useful in defining damage mechanisms. Specimens of depleted UN, ^{15}UN, and UN-UC (50-50 mole %) were irradiated at about 150°C in the ETR to determine the effects of He gas generated through the $^{14}N(n,\alpha)^{11}B$ reaction. The results will be compared with those from a high-temperature (1000°C) assembly still being irradiated. (auth)

44822 COMPATIBILITY OF $(U,Th)O_2$ WITH GRAPHITE DURING IRRADIATION. Conlin, J. A.; Cuneo, D. R.; Long, E. L. Jr.; Segasser, C. L. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 507-15(Jun 1970).

Bare $(U,Th)O_2$ fuel pellets were irradiated in a graphite structure to evaluate the potential of this type fuel for high-temperature gas-cooled reactors. The maximum fuel temperature was 1650°C at fuel pellet centers and 1370°C at fuel pellet-to-graphite interfaces. The experiment was terminated when fission-gas release rates increased by an order of magnitude and the radial temperature gradient from the fuel pellet centers to outer edges increased from 335 to 390°C. Postirradiation evaluation showed no evidence of chemical reaction or incompatibility between the fuel and the surrounding graphite. The graphite underwent no significant changes, but most of the fuel pellets were severely fractured. Burnup (2.4% heavy metal) was below that where the fuel swelling would be expected and optical measurements of two intact pellets showed no dimensional changes. (auth)

44823 SOME CONSIDERATIONS OF THE BEHAVIOR OF FISSION GAS BUBBLES IN MIXED-OXIDE FUELS. Li, Che-yu; Pati, S. R.; Poeppel, R. B.; Scattergood, R. O.; Weeks, R. W. (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 9: 188-94 (Aug 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

The critical size for a bubble pinned to a dislocation to continue

motion has been evaluated. The result differs from earlier line-tension models. A statistical method for treating bubble coalescence has been developed in which bubble size distribution is defined in terms of the number of gas atoms in a bubble on a logarithmic scale. Based on this method, a swelling and gas release model is developed and discussed. The resulting model can be readily adapted to numerical computation. (auth)

44824 MELTING POINT OF IRRADIATED URANIUM DIOXIDE. Bates, J. Lambert (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater.; 36: 34-6(Aug 1970).

The effects of irradiation at 1.27×10^{18} to 1.88×10^{20} fissions/cm^3 on the melting point of uranium dioxide were determined. (G.M.C.)

44825 RE-SOLUTION OF GAS ATOMS FROM BUBBLES DURING THE IRRADIATION OF UO_2. Turnbull, J. A.; Cornell, R. M. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 36: 161-8(Aug 1970).

Samples of UO_2 containing fission gas bubbles of radius 50 to 75 Å were irradiated to doses between 10^{17} and 10^{19} fissions/cm^3 at 200°C. Electron microscope examination was used to investigate the stability of these bubbles after irradiation with the view to determining the dose required to disperse bubbles of this size. The results show that the bubbles are dispersed by a dose $\lesssim 3 \times 10^{18}$ fissions/cm^3 and the gas atoms are knocked to small distances (<600 Å) by the re-solution process. (auth)

44826 NUCLEAR MAGNETIC RESONANCE STUDIES OF IRRADIATED BERYLLIUM OXIDE. Walter, J. A.; Troup, G. J. (Monash Univ., Clayton, Australia). J. Nucl. Mater.; 36: 189-99(Aug 1970).

Changes in the nuclear magnetic resonance (NMR) of ^{9}Be were studied in single crystal and polycrystalline BeO subjected to a range of γ and neutron irradiation doses. The results are compared with previous radiation damage studies of BeO. (auth)

Plastics and Other Materials

Refer also to abstract 44219.

44827 (CEA-CONF-1371) MEASUREMENT OF THE THERMAL MODULUS OF RIGIDITY ON THREE DIFFERENT CONCRETES UNDER THERMAL AND MECHANICAL STRESSES. Dubois, F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Dawance, G.; Noel, G. (Centre d'Etudes et de Recherches du Batiment et des Travaux Publics, Paris (France)). [nd]. 29p. (In French). (CONF-690344-1). Dep. CFSTI (U. S. Sales Only).

From 11th Meeting on Prestressed Structures, Paris, France.

The calculation of thermal stresses in nuclear reactor vessels is limited theoretically by the results furnished by thermoelasticity. The stresses obey the relation $\sigma = K.E.\alpha.\Delta T$. The elasticity modulus for concretes can only be determined experimentally. It is considered to be equivalent to the modulus of global deformation (Ed) of a concrete under defined thermal and mechanical stresses. The product $Ed \cdot \alpha$ is called thermal modulus of rigidity. The cylindrical reactor vessel is simulated by means of a concrete box girder with a constant section, under a temperature gradient and simultaneous prestress. By applying to this girder a constant bending moment, a mechanical effect opposed to the thermal effect is induced. The machine which strains the girder under constant moment is described. Results of tests performed on three concretes with various compositions and modulus of elasticity under temperature gradients of about 60 and 120°C are given. The artificial and mechanical age-hardening is found to eliminate most of the creep from the three girders within one or two months. The changes observed in the value of the product $Ed \cdot \alpha$ can be very large according to the nature of the chosen concretes. (auth) (France)

44828 COUNTING OF FISSION FRAGMENTS BY GLASS AS A FUNCTION OF THE TIME BETWEEN THE IRRADIATION AND ETCHING OF THE GLASS. Gorshkov, V. K. At. Energ. (USSR); 28: 504-5(Jun 1970). (In Russian).

Fission fragments leave in the surface of a silicate glass either round holes (at an incidence angle of ~0°) or comet-like traces. These tracks may be readily observed by means of a microscope if the glass is etched in hydrofluoric acid after the irradiation. The relative size of the craters depends on the angle of incidence and the fragment energy. The average size of the craters was also found to depend on the time t between the irradiation and etching of the glass, and on the annealing temperature of the glass. A ^{244}Cm source on an aluminum backing was used to irradiate the glass surface. A series of glasses were subject to irradiation a single time over a period of 10 months at room temperature. All the glasses were etched simultaneously in hydrofluoric acid, and it was found that the average diameter of the craters decreases with increasing lapse of time after the initial irradiation. The relative size of the craters decreases with increasing annealing time. The craters also become less visible with increasing time after the irradiation, and may be confused with background depressions in the glass which are similar to the craters from the fission fragments but are not connected with the irradiation. These results may be significant in the detection of superheavy nuclei in natural silicate deposits. (TTT)

44829 EFFECTS OF GAMMA RADIATION ON PROPERTIES OF LEATHER AND UNTANNED LEATHER. Strakhov, I. P.; Levenko, P. I.; Shifrin, I. G.; Metelkin, A. I.; Averkiev, V. P.; Pavlov, Yu. F.; Rybakova, G. D. At. Energ. (USSR); 29: 26-9 (Jul 1970). (In Russian).

The effects on tanned and untanned leather of gamma radiation from a ^{60}Co source at dosage rates from 1 to 10 MR were investigated. Low dose rates, such as 0.1 MR, caused structuration which increased the shrinkage time and tensile strength. Doses of 1 to 3 MR caused little change in the properties of skins. This is very important for sterilization. (auth)

44830 ORIENTATION DEPENDENCE OF BORON DIFFUSION. Okamura, Masahiro (Hitachi Ltd., Ibaraki, Japan). Jap. J. Appl. Phys.; 9: 848-9(Jul 1970).

The effects of oxidation on B diffusion in Si at different orientations were studied. Si slices of (100), (110), and (111) orientations were prepared and, after boron was deposited, oxidized at 1100°C for 60 min. in different atmospheres. Oxide layer thickness, sheet resistivity, and junction depth were measured. The resistivity increased with oxidation rate, owing to B redistribution. The plot of junction depth vs oxide thickness shows a clear orientation dependence, with the depth increasing with oxide thickness for (100) and decreasing for (111). (D.L.C.)

44831 RADIATION SHIELDING. (to Chemtree Corp.). British Patent 1,200,614. 29 Jul 1970. Priority date 30 Sep 1966, United States.

A radiation shielding material, composed of at least 10% by volume of elements with atomic numbers of 57 to 71 inclusive in metallic powder or compound form dispersed in a polyolefin, is described. The preferred polyolefin is polyethylene, and the preferred compound of the element is the hydride. The mixture can be set to form a structure of predetermined form. (B.L.M.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

44832 (IPPJ–82(J)) REPORT OF 1968 MITAKA MEETING ON GAS DYNAMICS IN GALACTIC AND SOLAR SPACES. (Nagoya Univ. (Japan). Inst. of Plasma Physics). 29 Jan 1969. 136p. (In Japanese). (CONF-690123). CFSTI (U. S. Sales Only).

Reports presented at the 1968 Mitaka Meeting, from January 29 to 30 1969, are given. The purpose of the Meeting held annually is to promote the works of cosmic astrophysics and cosmic-ray physics in association with plasma physics of the Nagoya University IPP. In the Meeting, therefore, phenomena and other items concerned, covering from those on a cosmology scale to those in interplanetary space in proximity of the Earth, are treated in terms of gas and magnetic-field structure dynamics. The total of 25 individual reports includes the following: X-ray sources, OSO, pulsar, etc.; (dynamics in magnetic-field structure) Faraday rotation, formation of galaxies, cosmic expansion, spiral arm, and nonlinear interstellar-gas motion; (plasma turbulent flow and shock) collisionless shock wave and energetic electrons; (heliomagnetosphere) interplanetary magnetic field, glow, hydrogen distribution, etc., cosmic electrons and nuclei, solar modulation, and so on; and (flare models) models, flare and magnetic field, magnetic field in corona, solar microwave bursts, etc. (NSA of Japan)

44833 PROGRESS IN COSMIC ASTRONOMY. Gruen, Marcel; Koubsky, Pavel. Pokroky Mat. Fyz. Astron.; 15: 62–76(1970). (In Czech).

The authors reviewed 109 published articles from a number of countries. They conclude that progress in cosmic astronomy, supplemented by developments in standard astrophysics methods, in the past 20 years have led to significant broadening of the range of radiation wavelengths that can be detected from space and to discovery of new types of bodies. The chief result of these studies is the discovery of intense energy changes. Further, bodies that have the highest energy equilibria are probably sources of high-energy radiation. Detailed study of significant changes has established the fact that the Universe is a system in which changes evolve slowly. Charts and tables show conditions of and data from numerous experiments, e.g., types of detectors used and measurements made, as well as wavelengths (both x and uv) under study, in satellite flights. (TTT)

44834 ANNUAL REVIEW OF ASTRONOMY AND ASTROPHYSICS. VOLUME 8. Goldberg, Leo (ed.). Palo Alto, Calif.; Annual Reviews Inc. (1970). 502p. $10.00.

Separate abstracts were prepared for the fourteen review articles included. (W.D.M.)

For abstracts of individual papers see: 44835, 44873–44877, 44892, 44893, 44930, 44931, 44949, 44962, 45045, and 45165.

44835 INFORMATION-PROCESSING SYSTEMS IN RADIO ASTRONOMY AND ASTRONOMY. Clark, B. G. (National Radio Astronomy Observatory, Green Bank, W. Va.). Annu. Rev. Astron. Astrophys.; 8: 115–38(1970).

Topics covered in some detail include general principles of information processing, on-line information-processing devices, and several examples of modern information-processing systems. (70 references) (W.D.M.)

Cosmic Ray Exposure Ages

44836 SPALLATION YIELDS OF XENON FROM IRRADIATION OF Cs, Ce, Nd, Dy, AND A RARE EARTH MIXTURE WITH 730-MeV PROTONS. Hohenberg, C. M. (Univ. of California, Berkeley); Rowe, M. W. J. Geophys. Res.; 75: 4205–9(1 Aug 1970).

A mass-spectrometric determination was made of the stable xenon isotopes that result from spallation of cesium, cerium, neodynium, dysprosium, and a mixture of rare earth elements by bombardment by 730-MeV protons. The results obtained suggest that the report that Angra dos Reis fission xenon differs from that in Pasamonte may not be valid, but rather that unusual spallation xenon yields are expected in Angra dos Reis, which complicates estimation of the fission xenon spectrum. Spallation correlation plots should be used with caution because a principal change in the spallation yield with varying targets occurs at ^{130}Xe, the isotope commonly used for normalization in such correlation plots. Other isotopes commonly considered remain about the same. (auth)

44837 METEORITES. Turner, G. (Univ. of Sheffield, Eng.). Essays in Phys.; 1: 113–64(1970).

The genetic relationships and origins of meteorites are discussed and the applications of meteorite analysis to mineralogy, astrophysics, and the structure and history of the solar system considered. The composition and structure of chondrites and iron meteorites are discussed. Natural variations in isotope abundance ratios comprising natural radioactivity, Pb–Pb ages, Rb–Sr ages, gas retention ages, extinct radioactivity, extinct ^{129}I, extinct ^{244}Pu, cosmic-ray effects, and trapped rare gases are considered. Meteorite orbits are discussed and future prospects in meteorite analysis with reference to lunar rocks indicated. (UK)

Stars

Refer also to abstracts 44944, 44987, 44999–45001, and 45045.

44838 COARSE ANALYSIS OF THE PECULIAR A STAR 46 DRA. Conti, Peter S. (Univ., Utrecht). Astron. Astrophys.; 7: 213–18(Aug 1970).

46 Dra is a double line spectroscopic binary of short period. Equivalent widths are derived from spectra showing both components and corrected for the luminosity difference of the pair. Equivalent widths are also derived for the B9V star, ν Cap. A curve-of-growth analysis relative to the standard A star HD 73666 shows that ν Cap is normal in composition. The relative analysis of 46 Dra shows that both components are peculiar A stars, slightly hotter than ν Cap. Both stars are overabundant in Sr, Y, Zr, Pt, and Hg, however, the components differ in these anomalies. The primary is also overabundant in Mn and Ga. The components are similar in composition in other common elements. (auth)

44839 EFFECT OF ABSORPTION LINES FOR Am AND Ap STARS IN THE PHOTOMETRIC SYSTEM OF THE GENEVA OBSERVATORY. Hauck, B. (Univ., Lausanne, Switzerland. Observatoire, Geneva); Van't Veer-Menneret, C. Astron. Astrophys.; 7: 219–26(Aug 1970). (In French).

The metallic absorption lines in Am and Ap stars are abnormally strong and numerous, with respect to the spectral type that can be deduced from their hydrogen lines. Thus one can expect an important blanketing effect of the metallic lines on the continuum of this type of stars. This effect must modify significantly the photometric measurements of the continuum and consequently the theoretical interpretation of the resulting indices. This work attempts to determine the correction of the Geneva photometric indices in order to obtain the values one should observe if the spectral lines were absent, taking into account the blocking effect of the absorption lines and the backwarming effect on the continuous emission. (auth)

44840 PHOTONEUTRINO ENERGY LOSS RATES. Chaudhuri, Probhas Ray (Indian Statistical Inst., Calcutta). Can. J. Phys.; 48: 944–9(15 Apr 1970).

The neutrino energy loss rate due to the photoneutrino process in a hot plasma, including the contributions from positrons in the blackbody radiation according to the photon–neutrino coupling theory, was obtained. This is compared with that obtained on the basis of the current–current coupling theory of weak interactions for a variety of conditions. (auth)

44841 DYNAMICS OF SUPERNOVA EXPLOSIONS. Apagyi, Barnabas. Fiz. Szemle; 20: 134–43(May 1970). (In Hungarian).

Hubble's law is used to determine the distances of galaxies and the flareup of supernovae in them. The flareup phenomenon has been explained by assuming that the energy released in the explosion is due to the gravitational energy of a rapid contraction. Subsequent theories considered the $^{56}Fe \rightleftharpoons 13\ ^4He + 4n$ equilibrium as the source of energy; if it shifts toward the right, an explosion will induce a rapid fusion reaction. This was further studied, assuming that the supernova possesses a core of $^{56}Fe + 26\ e^-$ gas; as the temperature increases, this core undergoes thermal dissociation into $13\ ^4He + 4n$ and to 2p and 2n. It is considered whether the rapidly occurring phenomena create nuetrinos by a free fall or by an impulse mechanism. There are barriers to the propagation of neutrinos within the stellar matter itself. Discovery of pulsars was an important contribution to the theory of supernovae; direct proof of these theories must await direct observation of a flareup event within the Milky Way. (TTT)

44842 DETERMINATION OF THE SHAPE AND OF THE LIMB DARKENING AT lambda 4230 OF THE COMPONENTS

OF THE ECLIPSING BINARY SZ CAMELOPARDALIS. Heintze, J. R. W. (Sterrewacth Sonnenborgh, Utrecht); Grygar, J. Bull. Astron. Inst. Czech.; 21: 77-91(1970).

Revised elements of the early-type binary system SZ Cam were derived from Wesselink's (1941) photographic light curve under the assumption that the stars can be represented by ellipsoids. The average ellipticity seems to be 0.410 instead of 0.305_8. It turns out that the derived limb-darkening coefficient depends on the ellipticity of the components. It is unknown whether the shape of the components can be represented by ellipsoids or not and therefore the derived limb-darkening coefficients are still rather uncertain. However, a much better agreement between observed and calculated light curve was obtained than ever before. The non-linear model CLV's that gave the best agreement belong to models with lower effective temperature than are expected according to spectral types. (auth)

44843 ABSOLUTE MAGNITUDE OF γ VELORUM. Baschek, B. (Univ., Heidelberg). Astron. Astrophys.; 7: 318-21(Aug 1970).

A spectroscopic determination of the absolute magnitude of the early B star γ^1 Vel (HR 3206) is given by analyzing the spectrum relative to γ Peg, ι Her, and η Hya. Assuming $M_v = -3.5$ for τ Sco, $M_v(\gamma^1\ \text{Vel}) = -3.2 \pm 0.4$ is derived. Depending on the choice of the absolute magnitude of the O type component, the absolute magnitude of the Wolf–Rayet component of γ^2 Vel (HR 3207) is M_v (WC 8) = $-4.5 \ldots -5.3$. (auth)

44844 PERIOD–AMPLITUDE RELATION OF CEPHEIDS IN THE GALAXY AND IN THE MAGELLANIC CLOUDS. Schaltenbrand, R. (Univ., Basel); Tammann, G. A. Astron. Astrophys.; 7: 289-91(Aug 1970).

It is shown that the period–amplitude relations of Cepheids in the Galaxy and in the Magellanic Clouds indicate no disagreement within the period ranges where a statistically sufficient number of photoelectrically observed Cepheids is known. The differences which apparently remain outside these period ranges can be explained by different period–frequency distributions. (auth)

44845 PECULIAR SPECTRUM OF AG CARINAE. Caputo, F.; Viotti, R. (Laboratorio di Astrofisica, Frascati, Italy). Astron. Astrophys.; 7: 266-78(Aug 1970).

The spectrum of the P Cygni star AG Carinae was analyzed and mean radial velocities derived for seven different epochs between 1949 and 1959. Several P Cygni lines of H, He I, N II, Si II, Si III, Si IV, Fe II, and Fe III and a few very weak lines of [S II] and [Fe II] were identified. The equivalent spectral type is variable from A1 I to B0 I. All the radial velocities are variable and differ between different ions, indicating a continuous and irregular mass ejection from the star. AG Car is surrounded by an extended envelope which is expanding with a velocity that is increasing towards the outermost region. From the Fe II and [Fe II] lines a mean temperature of 10,900 ± 600°K and an electronic density of about 3×10^7 cm^{-3} have been derived. The interstellar calcium K line is strong and is indicative of an absolute magnitude of –6m or 1 to 2 magnitudes brighter. No carbon and oxygen lines have been identified. This object is probably a massive star evolved from the main sequence. A detailed comparison with the nearby peculiar object η Car is also made. (auth)

44846 ORBIT OF VISUAL BINARY ADS 3390 (Σ 577). Hock, E.; Flinner, D. Astron. Astrophys.; 7: 242-3(Aug 1970). (In German).

Following the publication of the first provisional orbit of Hock revised elements, normal places with the arrangement of O–C, ephemerides, and dynamic parallaxes are communicated for ADS 3390. (auth)

44847 PROPERTIES OF BUMPS IN THE LIGHT-CURVES OF POPULATION I AND II CEPHEIDS IN FOUR STELLAR SYSTEMS. van Genderen, A. M. (Leiden Observatory). Astron. Astrophys.; 7: 244-8(Aug 1970).

The position and the frequency of bumps in the light curves of Cepheids as a function of the period was investigated, mainly for the Population I Cepheids in the Magellanic Clouds, the Galaxy, and M 31. The period–amplitude diagrams for Population I Cepheids of three of these star systems show a "zone of avoidance" between log P = 0.9 and 1; in this zone not only fewer Cepheids occur, but their amplitudes are much lower than in adjacent zones. (auth)

44848 MORE COMPARISONS OF NUMERICAL INTEGRATIONS IN THE GRAVITATIONAL N-BODY PROBLEM. Hayli, A. (Institut d'Astrophysique, Paris. College de France, Paris). Astron. Astrophys.; 7: 249-53(Aug 1970). (In French).

The evolution of two groups of gravitational 25-body systems was computed by numerical techniques. In each group the initial conditions were either identical or very close to each other. The calculations were performed on different computers with the same integration method and the same program. The initial conditions of the first group were those of the I.A.U. "Standard problem." Those of the second group were such that the virial coefficient is equal to 1. In both cases the reproducibility of these numerical experiments is limited to the beginning of the evolution. For that period very few close encounters occur and the motion of the bodies is governed mainly by the mean field. The reproducibility is all the better for the individual coordinates of these bodies which move far from the central region of the system. The instability of the solutions of the N-body gravitational problem as well as the integration method and the finite number of bits used by computers—this number is not the same for different computers—are responsible for the defect of reproducibility. (auth)

44849 PLASMA NEUTRINO EMISSION FROM STARS AND ITS ASTROPHYSICAL EVIDENCE. Chaudhuri, Probhas Ray (Indian Statistical Inst., Calcutta). Can. J. Phys.; 48: 935-43 (15 Apr 1970).

The emission of neutrino pairs by a stellar plasma is calculated according to the photon–neutrino coupling theory and is compared with the result obtained on the basis of the current–current coupling theory of weak interactions. The effect of the plasma neutrino emission on the evolution of white dwarfs is also discussed. It is observed that the small fraction of the observed white dwarfs with masses above 0.9 $M_\odot$ can be interpreted when the plasma neutrino emission is considered from the point of view of the photon–neutrino coupling theory. (auth) (Canada)

44850 EVOLUTION OF METAL-RICH STARS. Torres-Castilleja, Silvia. Berkeley, Calif.; Univ. of California (1969). 132p. University Microfilms Order No. 70-6244.

Thesis.

Evolutionary sequences for stellar configurations between 1 and 1.45 $M_\odot$ with chemical abundances varying from Z = 0.023 to 0.10 and from X = 0.60 to 0.68 were computed using the Berkeley stellar evolution program. The effect of the high metal abundance on the structure and evolution of the models was studied. It was found that for the compositions under consideration, the presence of a hydrogen-burning convective core is directly determined by the luminosity of the models in the main sequence. No core was present for an age zero main sequence model fainter than $M_{bol} = 4.6$. Isochrones were obtained from the models and were compared with the observed H–R diagrams of M 67, NGC 188, and NGC 6791 which have metal abundances 2 to 6 times higher than the solar metal abundance (Spinrad and Taylor 1969a, 1969b). The observed color–magnitude diagram for NGC 188 can be explained with a composition Z = 0.07, X = 0.62 for an age of 4.0×10^9 years. For the case of M 67 an age of 2.2×10^9 years for Z = 0.07, X = 0.62 was obtained, however the fit with the color–magnitude diagram is not good; in this case it is not possible to obtain a better agreement between theory and observations by changing only the chemical composition. The observations of NGC 6791 are in agreement with the isochrones of Z = 0.10, X = 0.60 for an age of 4.0×10^9 years. Masses and ages were determined for eighteen field stars, the average age of this group is considerably larger than the ages of NGC 188, M 67, and NGC 6791. An appendix is given where a detailed description of the opacity computations is presented. (Diss. Abstr. Int., B)

44851 EQUATION OF STATE FOR NEUTRON MATTER. Kistler, S.; Mittelstaedt, P.; Weyer, W. (Univ., Cologne). Z. Phys.; 234: 479-92(1970).

The equation of state for cold neutron matter was derived for densities of 10^{12} to 10^{16} g/cm^3. The energy density, the pressure, and the velocity of sound were calculated from nuclear forces by quantum mechanical many-body techniques, which are well established in nuclear physics. It is found that neutron matter is not bound and becomes superluminal and ultrabaric at densities of about 10^{15} g/cm^3. In order to justify these strange results it is shown that the same physical assumptions which lead to the superluminal and ultrabaric behaviour in the calculation yield the same effects also in the lorentz invariant classical models of Zeldovich, Bludman, and Ruderman. (auth)

44852 EFFECTS OF CENTRAL PULSARS ON SUPERNOVA ENVELOPES. Rees, M. J. (Inst. for Advanced Study, Princeton, N. J.). Astrophys. Lett.; 6: 55-8(Jul 1970).

The luminosity of an expanding supernova envelope is estimated, taking into account the possible energy input from a newly formed central pulsar, and it is shown that the general shape of the Type II supernova light curve can be reproduced. Other consequences of the hypothesis that pulsars form in Type II supernovae are mentioned briefly. (auth)

44853 RECOMBINATION LINES AT λ3 CM FROM THE CORE OF THE ORION NEBULA. Gordon, M. A. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett.; 6: 27-34(Jul 1970).

Observations of the 85α and 106β recombination lines show helium and hydrogen to have similar states of thermodynamic equilibrium and imply the ratio of helium to hydrogen number densities to be 0.073 ± 0.008. The 85α, 106β, 121γ, and 133δ hydrogen line intensities are consistent with a mean electron temperature of 10^4 °K over the core of the nebula but imply variations in temperature and hence variations in physical conditions over intervals of 1.5 arc min. (auth)

44854 SUPERGIANTS IN STELLAR ASSOCIATIONS AND GALACTIC CLUSTERS. Humphreys, Roberta M. (Vanderbilt Univ., Nashville). Astrophys. Lett.; 6: 1-3(Jul 1970).

Observational data are presented which support recent suggestions that the photoneutrino process is occurring in some of the M supergiants. (auth)

44855 HBV 475: EVOLUTION STAGE OF A PLANETARY NEBULA. Crampton, D. (Dominion Astrophysical Observatory, Victoria, Can.); Grygar, J.; Kohoutek, L.; Viotti, R. Astrophys. Lett.; 6: 5-9(Jul 1970).

Preliminary analysis of recent spectroscopic observations of HBV 475 suggests that a Wolf–Rayet star may be exciting a small nebula of rather high density ($N_e > 10^6$ cm^{-3}). It is also suggested that the forbidden lines are formed in several condensations of matter moving away from the central star with velocities of up to 250 km sec^{-1}. A new planetary nebula could be the result. (auth)

44856 ELECTRICAL AND THERMAL CONDUCTIVITIES IN NEUTRON STARS. Gentile, A. M. (Yeshiva Univ., New York). Astrophys. Lett.; 5: 245-6(Jun 1970).

Expressions for the electrical and thermal conductivity in the deep interior of a neutron star are given. They were obtained by solving the relativistic Boltzmann equation by a variational method. The electrical conductivity is only slightly higher than that obtained in the nonrelativistic calculation of Baym, Pethick, and Pines. (auth)

44857 EVOLUTION WITH MASS EXCHANGE OF CASE C FOR A BINARY SYSTEM OF TOTAL MASS 7 $M_\odot$. Lauterborn, D. (Univ., Goettingen, Ger. Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astron. Astrophys.; 7: 150-9(Jul 1970).

A binary system with a primary of 5 $M_\odot$, a mass ratio of 0.4, and a separation of 302 $R_\odot$ is followed through mass exchange which starts after exhaustion of central helium burning (case C). The final system contains a white dwarf of 1 $M_\odot$ and a main-sequence star of 6 $M_\odot$, separated by 840 $R_\odot$; the period is 2.8 years. A few observed case-C systems are briefly discussed. (auth)

44858 THE ATMOSPHERES OF HELIUM-RICH WHITE DWARFS OF SPECTRAL TYPE DB. Bues, I. (Univ., Kiel). Astron. Astrophys.; 7: 91-108(Jul 1970).

In order to explain the spectra of helium-rich white dwarfs, spectral type DB, flux constant model atmospheres are computed in the temperature range 11000 to 21000°K with surface gravities log g = 7 and log g = 8. For 13 different helium-rich compositions with varied abundances of hydrogen as well as metals, pressure–temperature relations and absorption coefficients are calculated for a grid of 12 values in temperature, 24 values in electron pressure, and 57 wavelengths with a special program. Stratifications and fluxes of the nonblanketed models with flux constancy of ≤ 1%, obtained by the method of Lucy, are discussed for T_{eff} = 18000, 15500, 13200, and 12000°K. Comparison with observed UBV colors indicates an extreme hydrogen deficiency with at least He : H ≥ 10^4 and 15500 > T_{eff} > 11000°K. From the absence of H_γ and the observed profile of He I 4472Å the abundance ratio turns out to be He : H ≥ 10^5. This ratio is confirmed by a detailed study of line profiles and equivalent widths of 10 He I lines. For the white dwarfs, EG 133, EG 145, and EG 149, best agreement is obtained with observation for a composition H : He = 1 : 10^5, Z = 2 × 10^{-4} with models of T_{eff} = 14700, 12000, and 1400°K, log g = 7, 7.5, and 7, respectively. (auth)

44859 STELLAR ROTATION: UNIFORMLY ROTATING STARS WITH HYDROGEN-LINE-BLANKETED MODEL ATMOSPHERES. COMPARISON WITH OBSERVATIONS OF A-TYPE STARS. Maeder, A.; Peytremann, E. (Observatoire, Geneva). Astron. Astrophys.; 7: 120-32(Jul 1970).

The energy distribution of uniformly rotating stars including hydrogen lines of the Balmer and Lyman series is computed for 5, 2, and 1.4 solar masses, for various rotational velocities and orientations. These results show some differences with former results in T_{eff} regions where hydrogen-line intensities vary quickly with T_{eff}, although the general behavior of rotational tracks in photometric diagrams is about the same. In order to make a comparison with observations, colors and parameters are computed in UBV and Geneva Observatory photometric systems. The predicted magnitudes, colors, and Balmer discontinuities show a very good agreement with observational results by Golay (1968) for A-type stars up to types near A7–F0. After this for stars up to F2–F5 where rotation is decreasing, observations show effects greater by a factor of 2 than those predicted by the models. The observed effects agree in the color-magnitude diagram with the values for nonuniformly rotating stars given by Strittmatter and Sargent (1966). Attention is given to the coincidence of the limit between the two types of behavior of rotational effects and the appearance of efficient convection in stellar outer layers. (auth)

44860 INSTABILITIES IN THE ENVELOPE OF THE Be STAR HD 37202 ζ TAU. Delplace, A. M. (Observatoire, Meudon, France). Astron. Astrophys.; 7: 68-85(Jul 1970). (In French).

The profiles of the underlying star were determined in order to estimate the contribution in emission and absorption of the envelope of HD 37202. These have been compared (1) to the theoretical profiles of Mihalas and (2) to the observed profiles of B stars of the same spectral type and of similar class of luminosity. The value of the radial velocity of the star obtained from the measurements was compared with the ones found in the literature. The study of the radial velocities of the absorption lines shows that the motions of the envelope have considerably increased since 1958. The strong oscillation (amplitude 60 km/s) discovered between 1960 and 1967 is a pseudo-periodic phenomenon connected with active phases of the inner layers. (auth)

44861 THE CONTINUUM OF MHα 328-116. Caputo, F.; (Laboratorio di Astrofisica, Frascati, Italy); Panagia, N.; Gerola, H. Astrophys. Lett.; 5: 275-7(Jun 1970).

The peculiar continuum of MHα 328-116 is found to correspond to that of a nebula where thermal collisions are responsible for the excitation, at $T_e = 1.3 \times 10^4$°K and $N_e = 5 \times 10^6$ cm^{-3}. (auth)

44862 INVESTIGATION OF LOW FREQUENCY INSTABILITY OF A ROTATING MAGNETIC NEUTRON STAR. Vandakurov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Astrophys. Lett.; 5: 267-9(Jun 1970).

Numerical integration of equations of nonradial oscillation for a rotating neutron star with internal toroidal magnetic field shows that self-excitation of oscillation is possible. (auth)

44863 TWO SUBLUMINOUS STARS NEAR THE GALACTIC PLANE. Greenstein, Jesse L. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.); Sargent, Anneila I.; Haug, Ulrich. Astron. Astrophys.; 7: 1-3(Jul 1970).

Photoelectric colors of OB stars in the Hamburg–Case Luminous Star survey revealed that only two out of more than 900 had the colorimetric characteristics of highly subluminous stars. Palomar spectra of LS 55° – 8 showed it to have weak, broad emission lines superposed on shallow absorption; it resembles an old nova. LS 63° – 198 is projected on Cam OB I, but is not a member. It has $\theta_{eff} \approx$ 0.15 and log g ≈ 6. Both are probably members of the halo or old disk population; the deduced space density of hot subdwarfs is then 9 × 10^{-7} pc^{-3}. (auth)

44864 NUMERICAL EXPERIMENTS ON THE ESCAPE FROM NON ISOLATED CLUSTERS. Hayli, A. (Institut d'Astrophysique, Paris. College de France, Paris). Astron. Astrophys.; 7: 17-23 (Jul 1970).

Isolated and nonisolated clusters with a mass distribution were studied by numerical techniques. The rates of escape of stars and of kinetic energy are compared with Hénon's theoretical expressions. Multiple encounters play a very important role in the escape phenomenon, at least for clusters with a small number of stars. This leads to a theoretical underestimate of the rates of escape when the stars have equal masses and to an overestimate when masses are unequal. For nonisolated clusters, the tidal field of the Galaxy is responsible for one half of the rate of escape of the stars. The energy of a star escaping because of the tidal effect grows slowly while that of a star escaping after an encounter increases very rapidly. The stars escaping because of the tidal effect leave the cluster in the vicinity of the equilibrium points. Encounters and the tidal field are not efficient enough to explain why very old open clusters are not observed. Other escape mechanisms have to be considered. (auth)

44865 UBV OBSERVATIONS OF THE MAGNETIC VARIABLE HD 125248. Maitzen, H. M.; Rakosch, K. D. (Ruhr-Univ., Bochum. Univ., Vienna). Astron. Astrophys.; 7: 10-16(Jul 1970). (In German).

Photoelectric observations in the UBV system of the Ap star HD 125248 were carried out with the 24-inch telescope at La Silla, Chile. The period of 9.295 days found earlier by Stibbs (1950) is confirmed within the limits of accuracy. The light curve in yellow has two maxima each in phase with a magnetic field maximum. This very remarkable double wave in V can perhaps be understood by the application of the oblique rotator theory considering a small flow of plasma in one direction along the magnetic lines of force within the stellar interior and on the surface of the star. A comparatively small flow in the opposite direction could then produce the secondary maximum visible in the yellow only because of the absorption by the inversely directed plasma flow at the same place (the "red pole"). Another possible explanation is the existence of a close red companion orbiting in 9.295 days around the Ap star and bound to its positive magnetic pole in analogy to HD 98088. (auth)

44866 EFFECTS OF REDDENING ON COLOR TRANSFORMATIONS. Gutierrez-Moreno, A.; Moreno, H. (Univ., Chile, Santiago). Astron. Astrophys.; 7: 35-48(Jul 1970).

By means of numerical integrations, it is shown that color-system transformation equations, obtained from unreddened stars, are not satisfied by reddened stars. Correction formulae are determined. These corrections are found to depend on the color of the star, the amount of reddening, and the transformation coefficients to the standard system. (auth)

44867 EXPLOSIVE NUCLEOSYNTHESIS IN STARS. Arnett, W. David; Clayton, Donald D. (Rice Univ., Houston, Tex. Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London); 227: 780-4(22 Aug 1970).

It is stated that recent calculations provide convincing evidence that the naturally occurring nuclei were produced in explosions. The required temperature, density, and expansion rate strongly suggest that before the explosion the objects concerned were ordinary evolved massive stars. These new developments are reviewed and a new table is presented indicating the author's hypothesis concerning the origin of the nuclei in the mass range $20 \leq A \leq 62$. (auth) (UK)

44868 SUPERFLUID TURBULENCE IN NEUTRON STARS. Greenstein, George (Yeshiva Univ., New York). Nature (London); 227: 791-4(22 Aug 1970).

The neutron superfluid in most neutron stars should be in a highly turbulent state. If so, this turbulence drastically alters the rotational properties. (auth) (UK)

44869 THERMONUCLEAR DETONATIONS IN COLLAPSING WHITE DWARF STARS. Wheeler, John Craig. Boulder, Colo.; Univ. of Colorado (1969). 164p. University Microfilms Order No. 70-5904.

Thesis.

The possibility is investigated that the progenitors of Type I supernovae are white-dwarf stars with mass ($M \sim 1.42\ M_{\odot}$) near the Chandrasekhar limit which become dynamically unstable due to electron capture on ^{24}Mg in their central regions. Models of spherical, nonrotating, isothermal ($T \sim 10^8$ °K) white-dwarf stars of uniform composition (90% ^{12}C or ^{16}O, 10% ^{24}Mg) are constructed in hydrostatic equilibrium. Magnetic fields and crystallization effects (except in the nuclear reaction rates) are neglected. A composition change which corresponds to electron capture on ^{24}Mg is then effected. The subsequent dynamic behavior of the models is studied with numerical hydrodynamics techniques. The models calculated collapse and heat up sufficiently to detonate the nuclear fuel (^{12}C or ^{16}O) in typically 20% of the stellar mass; however, the stars respond fast enough mechanically to prevent complete detonation and subsequent supernova explosion. No mass is ejected from any of the present models. The initial models, the present calculations, and the possible subsequent behavior of the models are discussed in some detail. The conclusion is that collapsing white-dwarf stars probably do not become supernovae as a direct result of thermonuclear detonations. The models may evolve into supernovae as other processes become active (i.e., the neutrino-transport process). The electron capture mechanism and several other mechanisms for rendering a white dwarf dynamically unstable are found to yield lifetimes too short compared to the conjectured pre-supernova lifetimes for the progenitors of Type I supernovae, $\sim 10^{10}$ years. Collapsing white-dwarf stars may become supernovae of a class other than Type I. (Diss. Abstr. Int., B)

44870 ANALYSIS OF THE LIGHT VARIATIONS OF THREE SHORT-PERIOD ECLIPSING BINARIES. Johnston, Kenneth John. Washington, D. C.; Georgetown Univ. (1970). 145p. University Microfilms Order No. 70-6341.

Thesis.

The light variations of UU Piscium, EM Cephei, and 44 i Bootis were investigated. UU Piscium was monitored in the V Color. The amplitude of the light variation was 0.03 magnitude. This is caused by the elliptical shapes of the component stars of UU Piscium. The phase of secondary minimum occurred at 0.55. The cause of this may be that the period of rotation of the component stars of UU Piscium is not synchronized with their orbital revolution, or their orbit is elliptical. Previous observations of UU Piscium by Magalashvili and Kumsishvili seem to indicate the orbit is elliptical but more observations are needed to confirm this. The variable star EM Cephei was found to have a period of 0.80627 days. There were many nights' data that did not agree with the mean light curve. Fluctuations in the period, caused by mass transfer between the component stars of EM Cephei, could account for the variations in the light curve. The variable star 44 i Bootis was observed in the $H\beta$ index. The period of this star has been found to be constant since 1960. The variation in the $H\beta$ index could be accounted for by mass transfer between the components of the binary system. (Diss. Abstr. Int., B)

44871 SELF-EXCITED VIBRATIONS IN PULSATING STARS. Rudd, Timothy James. Berkeley, Calif.; Univ. of California (1969). 85p. University Microfilms Order No. 70-6207.

Thesis.

Pulsating stars exhibit periodic fluctuations in their brightness and radii. A simple model for one of these stars is considered. Self-excited oscillations are shown to occur. The steady-state radial vibrations are investigated and seen to have the same asymmetries as the observed pulsations. A brief discussion of the pulsating star phenomenon is included. The general governing equations for the star are used, together with certain simplifying assumptions, to deduce a nonlinear one-zone model. This is analyzed for self-excited oscillations and a unique limit cycle of the discontinuous type is found to occur. It has the correct asymmetries in the phase plane thereby extending Krogdahl's earlier work based on a self-excited system of the van der Pol type. (Diss. Abstr. Int., B)

44872 PUL'SIRUYUSHCHIE ZVEZDY. (Pulsating Stars). Kukarkin, B. V. (ed.). Nestatsionarnye Zvezdy i Metody ikh Issledovaniya. (Variable Stars and the Methods for Their Investigation). Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1970). 372p. (In Russian).

The first book of the series of Variable Stars and Methods of Their Investigation consists of ten separate chapters on the problems of variability of pulsating stars of various types and their physical and spatial-kinematic properties. The role of these stars in studies of the structure of stellar systems is evaluated. It is shown that the properties of many stars, particularly Cepheid and RR Lyrae constellations, are described by the theory of pulsation of their external layers. (R.V.J.)

44873 THEORY OF STELLAR WINDS AND RELATED FLOWS. Holzer, T. E.; Axford, W. I. (Univ. of California, San Diego, La Jolla). Annu. Rev. Astron. Astrophys.; 8: 31-60(1970).

Certain aspects of steady, radial flows that are significant in astrophysics and space physics are discussed. An attempt is made to emphasize relatively formal and well-established features of the general theory of steady, radial, spherically symmetric flow. The purpose is to show that the results are of wide applicability, and may be used in discussing not only stellar winds, but also galactic winds, comet winds, the polar wind (and related processes in planetary ionospheres), and the classical accretion problem. (47 references) (W.D.M.)

44874 ATMOSPHERES OF VERY LATE-TYPE STARS. Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Annu. Rev. Astron. Astrophys.; 8: 87-114(1970).

The discussion in this review is restricted mainly to stars of M, S, and C spectral types. Under the main heading of gross properties topics considered include: spectral classification of M, S, and C stars; effective temperatures, luminosities, masses, and radii; elemental abundances; emission lines; magnetic field; space velocity; rotation; variability; and polarization. Theoretical models of the atmosphere are discussed in terms of the basic problem, equation of state, sources of opacity, convection, construction of model atmospheres, main features of the computed models, and validity checks on the assumptions. (197 references) (W.D.M.)

44875 OPTICAL OBSERVATIONS OF EXTRASOLAR X-RAY SOURCES. Hiltner, W. A.; Mook, D. E. (Yerkes Observatory, Williams Bay, Wis.). Annu. Rev. Astron. Astrophys.; 8: 139-60 (1970).

This review of optical observations of x-ray sources is concerned primarily with those sources for which there are well-established optical counterparts. A brief discussion of the methods

of optical identification is followed by remarks on individual objects. (79 references) (W.D.M.)

44876 NEUTRON STARS. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Space Flight Center, New York). Annu. Rev. Astron. Astrophys.; 8: 179-208(1970).

In this review the principal concern is with papers published since an earlier review by Wheeler (1966). No attempt is made to discuss the properties of pulsars as such, but reference is made to certain pulsar properties, both because their discovery has motivated certain investigations of neutron-star properties and because the subjects of neutron stars and pulsars will be inextricably linked from this point forward. Topics covered include equations of state, neutron-star models, atmosphere, crust, superfluid interior, cooling, vibration, magnetic fields, and rotation. (92 references) (W.D.M.)

44877 ASTRONOMICAL FOURIER SPECTROSCOPY. Connes, Pierre (CNRS, Orsay, France). Annu. Rev. Astron. Astrophys.; 8: 209-30(1970).

An attempt is made to answer the questions why, when, and how use Fourier spectroscopy. Emphasis is put on the techniques or experiments that have produced the greatest improvements compared to classical methods. Already collected or potential scientific results are not discussed. (93 references) (W.D.M.)

44878 PRELIMINARY STUDY OF THE STRUCTURE AND STABILITY OF MODEL ENVELOPES FOR LONG PERIOD VARIABLE STARS. Langer, George Edward. Boulder, Colo.; Univ. of Colorado (1969). 162p. University Microfilms Order No. 70-5866.

Thesis.

A large number (~50) of models for the envelopes of long-period variable stars were constructed, using the best available estimates for the luminosities and effective temperatures of typical variables. Models were constructed for 0.7, 1.0, 1.5, and 2.0 solar mass stars. Two different values for the mixing length (α = 0.7 and 1.0) were used and four different compositions were considered. The principal features of each model are tabulated and the effect of changing uncertain parameters such as the mixing length or the mass of the star is examined by comparing one model with another. (TSS) (Diss. Abstr. Int., B)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 44942.

44879 NUCLEI IN NEUTRON MATTER. Bethe, H. A. (Cornell Univ., Ithaca, N. Y.); Boerner, G.; Sato, Katsuhiko. Astron. Astrophys.; 7: 279-88(Aug 1970).

The equation of state at densities somewhat below nuclear is re-examined. The results are in qualitative agreement with previous authors, but there are quantitative differences. Up to $\rho_1 = 2.8 \times 10^{11}$ g/cm^3 there are neutron-rich nuclei and electrons; between ρ_1 and $\rho_2 = 4.34 \times 10^{13}$ g/cm^3 there is in addition a gas of free neutrons. At ρ_2, nuclei disappear rather suddenly, and are replaced by protons. As long as nuclei exist, their mass and charge increase monotonically with ρ; both Z and A are definite functions of ρ. (auth)

44880 COMPARISON BETWEEN RADIO AND OPTICAL RADIAL VELOCITIES OF H II REGIONS. Georgelin, Y. P. (Observatoire, Marseille). Astron. Astrophys.; 7: 322-9 (Aug 1970). (In French).

The radial velocities of H II regions are very interesting in the study of galactic spiral structure and have received very much attention during the last months at radio and optical wavelengths. The optical and radio investigations are compared. A comparison between optical radial velocities of different authors is made. The agreement between different surveys is very good (σ = 3.1 and 4.5 km s^{-1}). Radial velocity comparisons of extended sources are shown to be difficult. It is noted that only 18% of optical H II regions are detected in radio and only 22% of radio H II regions are detected in optical observations; this is due to observational selection effects. With two examples the difficulties of identifying radio and optical H II regions and of comparing their radial velocities are explained. The radio and optical radial velocities are found in good agreement (σ = 3.8 and 4.4 km s^{-1}). (auth)

44881 MODULATION EFFECTS IN THE PULSARS PSR 1451-68, 1749-28, AND 2045-16. Cole, T. W.; Hesse, K. H. (Cambridge Univ., Eng.). Astrophys. Lett.; 6: 59-60(Jul 1970).

Examination of the modulation effects associated with the "second periodicity" in a pulsar with an interpulse suggests that there may be interpulses in PSR 1451-68, 1749-28, and 2045-16. The true periods of these objects may therefore be twice the previously accepted values. (auth)

44882 PERIOD-LATITUDE CORRELATION OF PULSARS AND ITS IMPLICATIONS. Notni, P.; Oleak, H.; Schmidt, K.-H. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Astrophys. Lett.; 6: 61-3(Jul 1970).

The correlation between the periods and the concentration of pulsars to the galactic equator is investigated. Possible explanations are discussed; (1) the existence of a period–radio luminosity relation, or (2) a division into groups of various spatial distribution. (auth)

44883 DETECTION OF He 109α AND C 109α RECOMBINATION LINES IN SOUTHERN GALACTIC SOURCES. Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.); Wilson, T. L.; Gardner, F. F.; Milne, D. K. Astrophys. Lett.; 6: 35-7(Jul 1970).

Seventeen sources included in the NRAO–CSIRO–MIT survey (Wilson et al. 1970a) were surveyed for the He 109α emission. The line was observed in all sources investigated except the two components G0.5–0.0 and G0.7–0.0 in the Sagittarius region. The mean value of the helium-to-hydrogen ratio in all H II regions which show emission of the He 109α line is ρ(He 109α)/ρ(H 109α) = N(He$^+$)/N(H$^+$) = 0.088. The scatter in the individual data is large owing to the low signal-to-noise ratio of the observations. There appears to be no correlation between the observed abundance ratio N(He$^+$)/N(H$^+$) and deviations from LTE, as characterized by the observed ratio of integrated line profiles ρ(H 137β)/ρ(H 109α); this supports earlier conclusions that deviations from LTE affect two adjacent lines of He and H in the same way. The C 109α line was detected in three H II regions. (auth)

44884 MICROWAVE OBSERVATIONS OF THE PLANETARY NEBULA K3-50. Higgs, L. A. (National Research Council, Ottawa). Astrophys. Lett.; 6: 11-15(Jul 1970).

It has recently been discovered that the radio source in the direction of the planetary nebula K3-50 consists of several components. The main component, coincident with K3-50, has properties similar to DR21 and other "compact" H II regions. At the Algonquin Radio Observatory, the K3-50 radio source has been observed at 9.3, 4.5, and 2.8 cm, and a detailed map of the source has been made at the latter wavelength. These results combined with those obtained by other observers, allow the determination of the radio spectrum of the composite source from 0.4 to 15 GHz. Moreover, from the higher resolution observations, estimates of the spectra of individual components can be made. From the spectrum found in this manner for the main component, one can show that its emission measure is probably greater than 10^8 cm^{-6} pc, thus supporting the conclusion that is a compact H II region rather than a planetary nebula. (auth)

44885 A SMALL RADIO COMPONENT IN THE PLANETARY NEBULA NGC 7027. Miley, G. K.; Webster, W. J. Jr.; Fullmer, J. W. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett.; 6: 17-19(Jul 1970).

Observations were made of NGC 7027 at 2695 MHz with an interferometer of lobe spacing 0.6 arc sec. Fringes were detected over a wide range of hour angle, implying that a small component is contained within the main body of the nebula, located near the radio center. The observed fringe amplitude suggests that the brightness temperature of the small component is well in excess of the 13,900°K electron temperature for NGC 7027 estimated from the absence of recombination lines. (auth)

44886 OBSERVATIONS OF THE ORION NEBULA AT LOW RADIO FREQUENCIES. Terzian, Yervant; Parrish, Alan (Cornell Univ., Ithaca, N. Y.). Astrophys. Lett.; 5: 261-5(Jun 1970).

New, low-frequency flux density measurements are reported at 73.8, 111.5, and 196.5 MHz for the Orion Nebula. These observations were made with the 1000-ft radio telescope at the Arecibo Observatory. A short discussion on the spectrum and electron temperature of the Orion Nebula is given. (auth)

44887 OBSERVATION OF PRIMARY X-RAY SPECTRA FROM THE CRAB NEBULA AND DIFFUSE BACKGROUND. Ducros, G.; Ducros, R.; Rocchia, R.; Tarrius, A. (CEN, Saclay, France). Astron. Astrophys.; 7: 162-6(Jul 1970). (In French).

The results of an astronomical experiment in the x-ray energy-range from 2.5 to 30 keV are presented. It was performed in December 1968 from a rocket with an attitude control system. The detectors were two proportional counters whose axis were pointed at the Crab Nebula and at a point in the sky away from the galactic plane (RA = 2 h 24 m 30 s, $\delta = -40°$). On the Crab Nebula

spectrum and the diffuse x-ray spectra, an anomaly was seen which can be attributed to a monoenergetic radiation of about 5 keV, the origin of which is probably experimental. The experimental results are: (1) the Crab Nebula spectrum follows the exponential law: $dN/dE = 8.42\ E^{-2.048 \pm 0.05}$ photons $cm^{-2}\ s^{-1}\ keV^{-1}$. The upper limit of the Fe XXV and Fe XXVI rays is 2.10^{-2} photons $cm^{-2}\ s^{-1}$. (2) two spectra, one giving an upper limit and another a lower limit of the diffuse x-rays, were obtained, the first one from a large angular aperture detector, the second through the results from two detectors with different angular apertures. These two spectra follow exponential laws. (auth)

44888 ULTRAVIOLET ABSORPTION LINES IN H I REGIONS HEATED BY COSMIC RAYS. Silk, Joseph (Princeton Univ. Observatory, N. J.). Astrophys. Lett.; 5: 283-5(Jun 1970).

A small but significant fraction of the more abundant atoms in H I regions will be ionized by low-energy cosmic rays, if such particles are indeed responsible for heating and ionizing the neutral hydrogen. Some of the higher ion states in H I regions should be detectable by rocket or satellite spectroscopic observations of the ultimate absorption lines. (auth)

44889 OPTICAL AND X-RAY SYNCHROTRON RADIATION FROM THE CRAB PULSAR. Truemper, J. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Astrophys. Lett.; 5: 271-4(Jun 1970).

It is assumed that the Crab pulsar is a rotating magnetic neutron star whose magnetic moment is approximately at right angles to the rotation axis. The synchrotron radiation is calculated from the electrons which are accelerated in the wave zone. It is shown that the synchrotron spectrum extends up to the hard x-ray range if magnetic fields in the wave zone are assumed to be of the order 10^6 Gauss. The observed ratio of pulsar energy flux to that of the nebula can be explained in this model. (auth)

44890 PULSARS AND THE DISTRIBUTION OF CELESTIAL GAMMA RAYS. Pinkau, Klaus (Max-Planck Institut fuer Physik und Astrophysik, Garching, Ger.). Phys. Rev. Lett.; 25: 603-5 (31 Aug 1970).

The flux of celestial gamma rays from discrete sources (for example, pulsars) is calculated, showing that these sources emit fluxes of several 10^{-6} quanta/cm^2 sec over regions of several tens of degrees (among them Vela X). Hence they should be observable. The calculations show further that the high gamma-ray flux values of OSO-III follow from the expected correlation of cosmic-ray sources with regions of large hydrogen density. (auth)

44891 PULSAR SUBPULSES AND THE EMISSION PROCESS. Cole, T. W. (Cavendish Lab., Cambridge, Eng.). Nature (London); 227: 788-91(22 Aug 1970).

A further regular phenomenon in the subpulse behavior of pulsars is described. The drift speed of successive subpulses follows a sawtooth pattern with a linearly increasing drift speed and sudden jumps as the speed drops to repeat the cycle. (auth) (UK)

44892 RADIOFREQUENCY RECOMBINATION LINES. Dupree, A. K.; Goldberg, Leo (Harvard Coll. Observatory, Cambridge, Mass.). Annu. Rev. Astron. Astrophys.; 8: 231-64(1970).

Recombination lines can provide important information on the behavior of atoms in highly excited states, on the physical properties of the interstellar medium, and on the large-scale structure of the Galaxy, but only if a reasonably accurate theory of line intensities is available. Therefore, this review concentrates most strongly on recent developments connected with the theoretical interpretation of observations and on those observations that seem most relevant to the evaluation of theories. (84 references) (W.D.M.)

44893 PULSARS. Hewish, A. (Cambridge Univ., Eng.). Annu. Rev. Astron. Astrophys.; 8: 265-96(1970).

An attempt is made to present what is known about pulsars from observation. The theoretical situation is then surveyed briefly, and it is seen that while no model can yet be regarded as satisfactory, the field is narrowing. (102 references) (W.D.M.)

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Refer also to abstracts 45087 and 45111.

44894 SOLAR MICROWAVE SCINTILLATION. Badillo, Victor L. (Manila Observatory). Radio Sci.; 5: 979-82 (Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

With the Sun as a source, scintillations at four microwave frequencies were observed for 1 year. Scintillation was a daily occurrence at sunrise at elevation angles from 1.5 to 7°. This observation indicates the continued presence of point sources on the Sun during the peak of the sunspot cycle. It also suggests that the peculiar terrain configuration along the propagation path is conducive to the production of irregularities in the troposphere. Scintillation data can provide information about the troposphere and about the spectrum of the slowly varying component of solar emission. (auth)

44895 HYDRODYNAMICS OF AN ATMOSPHERE EXCITED BY AN UNDERLYING TURBULENT CONVECTIVE ZONE. II. RESPONSE OF AN ATMOSPHERE TO AN APPLIED RANDOM BODY-FORCE. Souffrin, P. (Observatoire, Nice. Academy of Science, Moscow). Astron. Astrophys.; 7: 227-41(Aug 1970).

The response of atmospheres to stationary random applied forces homogeneous over horizontal planes is formulated in a very general way. The occurrence of divergences at cutoff frequencies in the special case of an isothermal atmosphere is discussed. The analysis applies without modifications to a large class of models characterized by a propagation operator whose Green's function is singular when the group velocity vanishes. These divergences are ultimately related to the lack of reflections in the model and it is shown that the common energy argument is inadequate. This view is supported by a detailed analysis of the response of two models: the semi-infinite isothermal atmosphere bounded by a rigid bottom, and an infinite model with reflections at one level. The response is discussed in terms of the spatial extension and coherence of the momentum sources. It is shown that the response to a white-noise force can be enhanced at frequencies different from the local cutoff frequency of the region where the force acts. A preliminary discussion of the implications of this result to the situation prevailing in the solar upper layers strongly suggests the relevance of this study to the interpretation of the photospheric oscillation. (auth)

44896 UNSTABLE GRAVITATIONAL MODES IN THE OUTER SOLAR CONVECTION ZONE. Smeyers, P. (Univ., Louvain, Belg.). Astron. Astrophys.; 7: 204-9(Aug 1970).

Unstable gravitational modes of a detailed solar envelope model are determined in the adiabatic approximation. The behavior of the unstable modes for high degree spherical harmonics is considered, both by numerical integrations and by the development of an asymptotic representation. Finally, the global overstability introduced by rotation is studied by means of the usual perturbation method. (auth)

44897 DEVELOPMENT AND SPATIAL STRUCTURE OF PROTON FLARES NEAR THE LIMB AND CORONAL PHENOMENA. III. COSMIC RAYS FLARE ON NOV. 18, 1968. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 21: 67-70(1970).

Some typical features of the Nov. 18, 1968 proton flare with the ascent of the magnetic tube in the system of the opposite magnetic fields of the spot group are discussed. By means of the application of a known mechanism of interaction one can explain the origin and space development of these flares with characteristic emissions. The energy of ejected particles and photons draws upon the energy of the magnetic fields in the process of their annihilation. (auth)

44898 DEFECT OF THE NUMBER OF SOLAR FLARES AND SUNSPOTS NEAR THE CENTRAL MERIDIAN. Pajdusakova, L. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 21: 71-2(1970).

It is stated that the number of observed flares as well as their measured area near the central meridian show a decrease. The defect is manifested in spot areas to which especially large groups contribute. It is shown that the number of microflares as well as individual nuclei of spots and of groups do not exhibit a defect toward the central meridian. Thus, one may consider that the defect in the closest proximity of the central meridian does not concern the formation of flares and of spot nuclei but it rather pertains to their further development, of course, unless it is an effect caused only by observation. (auth)

44899 CONTRIBUTION TO THE FORM OF BUTTERFLY DIAGRAMS IN CONNECTION WITH THE DIFFERENTIAL ROTATION OF THE SUN. Kopecky, M. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 21: 73-6(1970).

It is shown that the overall shape of "butterfly diagrams" of sunspots can be closely connected with the differential rotation of the Sun. This fact could favor those theories of the periodicity of solar activity that proceed from the differential rotation of the

Sun as one of the chief factors of the spot-formation process. (auth)

44900 ABUNDANCE OF IRON IN THE SOLAR PHOTOSPHERE. REMARKS CONCERNING A PAPER BY JOHN E. ROSS (1970). Garz, T.; Richter, J.; Holweger, H.; Unsoeld, A. (IUniv., Kiel). Astron. Astrophys.; 7: 336-9(Aug 1970).

The contention made by Ross (1970) that the "new" value of the solar iron abundance log ϵ (Fe) = 7.60 ± 0.15 is considerably too high is shown to be unjustified. Some general remarks concerning the accurate determination of abundances and a few correcting statements concerning questions of priority are included. (auth)

44901 ORIGIN OF THE SOLAR WIND VELOCITY VARIATIONS. Couturier, P.; Leblanc, Y. (Observatoire, Meudon, France). Astron. Astrophys.; 7: 254-65(Aug 1970).

A close relationship between the occurrence of coronal enhancements and the increase of the solar wind velocity is demonstrated. The period analyzed is September to December 1962. The coronal enhancements observed at meter wavelength and at 5303 Å are permanent regions where the electron density and temperature are higher than those of the "quiet corona." Each recurrent peak of solar-wind velocity is correlated with a coronal enhancement, and the magnetic sector boundaries correspond to some of these enhancements only. The data at 5303 Å allowed a localization of the hemisphere of the enhancements which cause the north–south asymmetry identified by Siscoe and Coleman (1969) during the period December to January 1965. The discussion of the results shows that the excess of electron density and temperature in localized regions of the corona (near 0.5 $R_\odot$) are the major sources of the solar-wind activity. Radio and 5303-Å observations allow a derivation of the excess of electron density and temperature and the latitude of the enhancements. These values introduced in various models of solar wind already developed in the literature give a qualitative understanding of the observations: a spherically symmetric model can account for the increase of the solar-wind velocity related to the excess of the electron density and temperature of the enhancements; a spherically symmetric model with a superposed perturbation of pressure can account for the north–south asymmetry related to the latitude of the enhancements; a model of coronal magnetic fields gives large unipolar regions closely associated with the coronal enhancements. Finally, a streamer model connects the large structures of the solar wind to sources (enhancements) in the corona. (auth)

44902 CHROMOSPHERIC ABUNDANCE OF IRON. Athay, R. G. (High Altitude Observatory, Boulder, Colo.). Astron. Astrophys.; 7: 305-10(Aug 1970).

A critical comparison is made between the methods of deriving the chromospheric iron abundance used by Pecker and Pottasch (1969) and by Athay (1968). It is suggested that the differences in the results obtained by the two methods are explainable in terms of the inherent inaccuracies in either of the methods. An alternative source of the differences is an inconsistency between Fe I and Fe II f-values. (auth)

44903 INTERPRETATION OF INFRARED SPECTROPHOTOMETRIC SOLAR MEASUREMENTS. Gay, J. (Observatoire, Meudon, France). Astron. Astrophys.; 7: 24-34(Jul 1970). (In French).

It has been suggested (Gay, 1970) that some far-infrared continuous absorption stronger than H^- free–free absorption could be present in the solar atmosphere. An attempt is made to explain along this line the rather conspicuous discrepancies between measurements of the solar brightness temperature, in this spectral region, and the theoretical values that can be computed from the most recent models (Lêna, 1970; Gingerich, 1969). (W.D.M.)

44904 DETERMINATION OF THE VELOCITY PROFILE OF THE SOLAR WIND IN REGIONS OF RAPID ACCELERATION OF THE CORONAL PLASMA. Gordon, I. M. (Inst. of Radiophysics and Electronics, Kharkov). Astrophys. Lett.; 5: 247-9(Jun 1970).

Temperature estimates of the disturbed coronal plasma above plages, derived from the duration of solar bursts of types I, III, and V, are in complete agreement with those based on the interpretation of radio echoes from the Sun. A method is proposed for the determination of the velocity profile of the solar wind in regions of rapid acceleration above the plages, based on the interdependence between the velocity and temperature of the accelerated coronal plasma. The temperature can be determined from the lifetime of solar bursts of types I, III, and V, which are presumed to be equal to the collision damping time. (auth)

44905 INTERDEPENDENCE BETWEEN SOLAR RADIO BURSTS OF TYPES I AND III AND NONLINEAR PROCESSES IN THE CORONAL PLASMA. Gordon, I. M. (Inst. of Radiophysics and Electronics, Kharkov). Astrophys. Lett.; 5: 251-5(Jun 1970).

There is ample evidence, not interpreted as yet, that solar radio bursts of types III and V are observed in association with bursts of type I but at the lower frequencies. To explain this phenomenon it is suggested that Langmuir waves with low phase velocities $V_p \simeq 2V_{Te}$, excited by the suprathermal electrons which are responsible for the bursts of type I, are accelerated by nonlinear scattering on thermal electrons to phase velocities of approximately 0.1 to 0.6 c. The resulting K-spectrum of the Langmuir waves $W_k \propto K^{-\frac{1}{2}}$ leads to the rapid acceleration of the electrons to velocities V_0 of approximately 0.1 to 0.6 c, and it is suggested that these electrons are exciters of the bursts of types III and V. (auth)

44906 DIFFERENTIAL ROTATION OF THE PHOTOSPHERIC MAGNETIC FIELD. Wilcox, John M. (Univ. of California, Berkeley); Howard, Robert. Solar Phys.; 13: 251-60(Aug 1970).

The differential rotation of the large-scale photospheric magnetic field was investigated with an autocorrelation technique using synoptic charts of the photospheric field during the interval 1959–66. Near the equator the rotation period of the field is nearly the same as the rotation rate of long-lived sunspots studied by Newton and Nunn. Away from the equatorial zone the field has a significantly shorter rotation period than the spots. Over the entire range of latitudes investigated the average rotation period of the photospheric magnetic field was about 1¼ days less than the average rotation period of the material observed with Doppler shifts by Livingston and by Howard and Harvey. Near the equator the photospheric field results agree with the results obtained from recurrent sunspots, while above 15° the photospheric field rotation rates agree with the rotation rates of the K corona and the filaments. (auth)

44907 VERTICAL VELOCITIES AND HORIZONTAL WAVE PROPAGATION IN THE SOLAR PHOTOSPHERE. Musman, Steven; Rust, David M. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys.; 13: 261-86(Aug 1970).

The Sacramento Peak Doppler–Zeeman Analyzer was used to study the velocity and magnetic fields in 60″ × 300″ areas on the solar disk. The steady component of the line-of-sight velocity and longitudinal magnetic fields were mapped and compared with the coarse Ca^+ network. The collective phase behavior of the 5-min oscillations was studied in detail. Large scale phase coherence was found, including waves with typical horizontal phase velocities of 100 km/sec which could be followed up to 50,000 km. The important oscillatory features were interpreted in terms of the properties of modified sound waves. No apparent relationship was found between the steady and oscillatory fields. (auth)

44908 TEMPERATURE IN LINE-GAP REGIONS. Grossmann-Doerth, U. (Fraunhofer Institut, Freiburg 1. B.). Solar Phys.; 13: 287-91(Aug 1970).

The small regions in the photosphere where many absorption lines weaken have been investigated by several authors. Sheeley attempted to explain the weakening of neutral lines in terms of a temperature increase on the basis of a simple theoretical model. It is shown that this model is not applicable but that a modified theory is able to interpret the observed behavior of both neutral and ionized lines in terms of a temperature increase of a few percent. (auth)

44909 TIME AND SHAPE CHANGES OF THE SUPERGRANULAR NETWORK. Sykora, J. (Astronomical Inst., Skalnate Pleso, Czech.). Solar Phys.; 13: 292-300(Aug 1970).

From 20 K_{2H} spectroheliograms, time and shape changes of the supergranular network were investigated by means of autocorrelation curves. It was found that supergranules are lengthened in the direction of the solar rotation and this flattening fades out with growing activity of the region. Dimensions of the supergranular network increase with the activity of the corresponding region. The average diameter of the supergranules in the inactive regions is larger in the maximum of the solar cycle than in its minimum. The contrast of the calcium emission with respect to the background is double in the solar maximum in comparison with that in the minimum. (auth)

44910 FORMATION OF THE Ca II K LINE IN A SPINNING SPICULE. Avery, Lorne W. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 13: 301-11(Aug 1970).

The emission of the Ca II K line from a spinning cylindrical spicule model is considered. In order to reproduce the observed spicule K-line profiles, the model must have both radial and axial gradients in N_e and T_e. The rotating spicule model is optically thin at all heights and is hotter and more dense than a stationary

model computed in a previous paper. It is proposed that the so-called Type I and Type II spicules may be structurally the same features, with different rotational velocities. (auth)

44911 CONTINUUM INTENSITY OF THE UMBRA OF LARGE SUNSPOTS. Maltby, P. (Univ. of Oslo). Solar Phys.; 13: 312-18(Aug 1970).

Spectral observations of large sunspots during the period June 1968–Dec. 1969 in five wavelength regions between λ4795 and λ6775 are discussed. Selecting the best observations of two very large sunspots, slightly lower umbral intensities were found than derived by earlier observers. It is suggested that the small difference may be explained by the fact that earlier observers have used an average value, whereas it is believed that the minimum value gives a more correct estimate of the umbral intensity. (auth)

44912 INTENSITY PROFILES OF A SUNSPOT NEAR THE SOLAR LIMB. Mallia, E. A. (Oxford Univ.). Solar Phys.; 13: 319-22(Aug 1970).

Photoelectric observations of the intensity profile of a sunspot at a heliocentric angle of 76° at four wavelengths are reported. An intensity peak at the center–side penumbra–photosphere border predicted by Jensen et al. (1969) was observed. (auth)

44913 UMBRAL FLASH AS A MAGNETO–ACOUSTIC WAVE PHENOMENON. Havnes, Ove (Univ. of Oslo). Solar Phys.; 13: 323-9(Aug 1970).

The suggestion that an "umbra flash" may be caused by a magneto–acoustic wave phenomenon is examined. It is suggested that the flash in Ca II lines is formed during the compressional stage in a magneto–acoustic wave. The compression which is assumed to be adiabatic will produce a rise in temperature and a corresponding increase in number of Ca II atoms. The variations in line emission (absorption) coefficient of the Ca II K line are calculated on this assumption and are found to be in general agreement with the observed variations. Other observed quantities as proper motion, magnitude of line shift, etc., also agree with the wave hypothesis. Further observations which may serve as tests on the wave hypothesis are suggested. (auth)

44914 DEVELOPMENT AND FLARING OF AN ACTIVE REGION EXHIBITING UNUSUAL MAGNETIC STRUCTURE. II. ACTIVE REGIONS. Foukal, Peter (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 13: 330-47(Aug 1970).

The one-day development of a young bright region with loops (BRL) led to the 1N flare of 00:35 UT, April 25, 1968. The development of the active region is followed over the two previous rotations, and the peculiar polarity of the BRL, in which neither polarity is clearly leading, is explained from its location on the boundary of two large older active regions. It is likely that the flare occurred as a result of the relaxation of the unusual polarity in the BRL. The prominent active region filament is shown to have formed from the connection of two filaments previously existing in the older AR's. From the lack of meter wave radio emission it is concluded that a very closed field configuration exists in the AR. This is supported by observation of surges contained by the magnetic field, traveling at between 110 and 190 km sec^{-1}. The x-ray emission measure is derived and suggests that the x-ray emission volume is considerably smaller than that emitting Hα. Comparison of the microwave and x-ray temperatures poses the problem of why the thermal free–free emission in microwaves is so weak from such a strong thermal bremsstrahlung x-ray source. (auth)

44915 SOLAR ACTIVE REGIONS AT MILLIMETER WAVELENGTHS. Kundu, M. R. (Univ. of Maryland, College Park). Solar Phys.; 13: 348-56(Aug 1970).

Some properties of solar active regions at 9-, 3.5-, and 1.2-mm wavelengths are discussed. The regions have excess brightness temperatures of up to 1000, 700, and 150 K at 9-, 3.5-, and 1.2-mm wavelengths. The background radiation at 3.5 mm is often seen to be "absorbed" in regions closely coincident with Hα dark filaments on the disk. Interpretation of this "absorption" as due to the large optical thickness of the overlying filamentary material leads to an estimate of electron density in the filaments. The 9- and 3.5-mm-λ regions show almost one-to-one correspondence with the Ca-plage regions as well as with the regions on magnetograms. The latter relationship suggests the possibility of measuring chromospheric magnetic fields from the measurement of polarization at millimeter wavelengths. (auth)

44916 RADIO SPECTRUM OF TWO ACTIVE REGIONS. (RESULTS OF THE TOTAL SOLAR ECLIPSE OF NOV. 12, 1966). Drago, Franca Chiuderi (Goddard Space Flight Center, New York). Solar Phys.; 13: 357-71(Aug 1970).

The results of the total solar eclipse of November 12, 1966, observed at 8 different wavelengths between 3 and 21 cm, were studied and the spectrum of two active regions present on the disk was deduced. It is shown that the observed increase of the flux of the most intense source in the range 3 to 10 cm is due to geometrical effects. Neglecting the influence of the magnetic field, the following quantities are deduced: (a) the mean and central temperature of the coronal condensation; (b) the $\int_{corona} N^2 dh$ (N = electron density). Both these quantities are in good agreement with optical observations. (auth)

44917 VARIATIONS IN SOLAR EMISSION AT 3.3 mm WAVELENGTH AND THEIR RELATION TO FLARES. Mayfield, Earle B. (Aerospace Corp., El Segundo, Calif.); Higman, John; Samson, Clifton. Solar Phys.; 13: 372-88(Aug 1970).

An investigation of variations in solar radio emission at 3.3 mm wavelength as observed with an antenna of half-power beamwidth of 2.8 arc-min indicates the existence of hot stable regions associated with sunspots. These regions are enhanced from 240 K (4%) to more than 3200 K (50%) over the quiet center of the disk temperature of 6,600 K. Positions of maximum enhancement occur near the neutral lines of primarily bipolar magnetic fields as determined from mangetograms of the longitudinal component of the field. Fourteen of the 113 regions studied were observed to produce flares reported as importance class 2 or greater during the period from mid-February through mid-August 1967. Eleven of the regions which flared had an enhancement of 8.5% or greater and a temperature gradient of 0.5%/deg or greater. (auth)

44918 FURTHER X-RAY SPECTRA OF SOLAR ACTIVE REGIONS. Batstone, R. M.; Evans, K.; Parkinson, J. H.; Pounds, K. A. (Univ. of Leicester, Eng.). Solar Phys.; 13: 389-400 (Aug 1970).

Measurements of the solar x-ray spectrum between 3 and 15 Å are reported. They were made with two slitless Bragg crystal spectrometers flown on a Sun-pointed Skylark rocket on August 8, 1967. The use of beryl crystal has provided higher spectral resolution than hitherto in the spectral range 12 and 15 Å leading, in particular, to a revised identification of the strong line at 13.71 Å. Separate components of the stronger emission lines are clearly seen from each of three coronal active regions which may be identified on radio and x-ray spectroheliograms. The absolute line fluxes are used to determine a model for each active region in terms of the differential emission measure as a function of electron temperature. Emission lines due to the transition $1s^2\ ^1S_0 - 1s2s\ ^3S_1$ in several helium-like ions are identified and values of the local electron density derived from measurement of the line flux in these ions. (auth)

44919 MAJOR Hα FLARES IN CENTERS OF ACTIVITY WITH VERY SMALL OR NO SPOTS. Dodson, Helen W.; Hedeman, E. Ruth (Univ. of Michigan, Ann Arbor). Solar Phys.; 13: 401-19 (Aug 1970).

Major Hα flares (importance ≥2) in plages with only small or no spots constitute a rare but well observed aspect of solar activity. Information relating to 83 such flares has been assembled and studied. In the years 1956–1968 these flares represented ~7% of all confirmed flares of importance ≥2. In general, the flares were of unusually long duration and rose to maximum intensity slowly. A flash phase was often absent or poorly defined. In a number of cases, the flare emission included two bright filaments more or less parallel. The flares usually occurred during the late, flare-poor phase of a center of activity, and their outbreak did not presage a resurgence of activity in subsequent rotations. The flares were frequently associated with the position of dark filaments. Like major flares in general, the flares in regions with small or no spots usually were associated with long-enduring radiation (gradual rise and fall and/or postburst increase) at ~ 10 cm, and with x-ray enhancements (2 to 12 Å) at least as great as 4 times the quiet Sun. They were deficient, in the associated occurrence of strong, impulsive, centimetric bursts and of x-ray events >20 times the quiet Sun. The absence of large spots apparently did not inhibit the occurrence of Type II bursts. Only 41% of the major flares here studied were accompanied by shortwave fades and of these ionospheric disturbances only a few were great events. In general the flares were not followed by the detection of high energy particles or the onset of geomagnetic storms. However, a few of the flares (including those of 1967 January 11 and February 13) apparently were associated with well observed particle emission and suggest that the presence of a large complex spot is not always necessary for the acceleration of energetic particles or the emission of solar plasma at the time of a large Hα flare. (auth)

44920 THEORY OF SOLAR RADIO PULSATION. Chiu, Y. T. (Aerospace Corp., El Segundo, Calif.). Solar Phys.; 13: 420-43 (Aug 1970).

It is shown that the observed modulation of some coronal microwave, x-ray, and Type III emission into pulses of 10-sec intervals is a consequence of the stimulation of electron cyclotron waves propagated in the whistler mode in dipole-like bipolar regions of dimension $\approx 0.2\ R_\odot$. Assuming that a power law spectrum of ≥10-keV electrons with a slope similar to solar flare protons can be trapped in a bipolar region, it is shown that whistlers can be generated by pitch-angle instability. The resultant ≈10-sec bounce motion of whistler wave trains leads to enhanced, modulated emission in microwave and x-ray frequencies by pitch-angle scattering of MeV electrons, and to modulated Type III emission by scattering with coherent plasma waves. A direct prediction of the theory is the existence of sympathetic pulsations at two sources a fraction of a solar radius apart. A second test of the theory is that modulated Type III emission should show strong polarization. (auth)

44921 RELATIVE INTENSITY OF SECOND BRANCHES OF U-LIKE SOLAR RADIO BURSTS. Smith, D. F. (Shternberg Astronomical Inst., Moscow). Solar Phys.; 13: 444-7(Aug 1970).

The purpose of this note is to examine the suggestion of Fokker (1970) to explain why the second branch of U bursts is ill-developed and to present an alternate possible explanation that was suggested by an examination of the trajectories derived by him. (auth)

44922 80 MHz OBSERVATIONS OF A MOVING TYPE IV SOLAR BURST, MARCH 1, 1969. Riddle, A. C. (CSIRO, Sydney). Solar Phys.; 13: 448-57(Aug 1970).

The 80-MHz emission from a moving Type IV source was observed as the source moved from 2 to $5\frac{1}{4}\ R_\odot$ from the center of the Sun. The emission came from a plasma cloud ejected in association with an extensive solar prominence. The cloud appeared to move with a speed (~270 km/sec) approximating the local Alfvén velocity in the corona. At $2\ R_\odot$ the emission was from a single unpolarized source, while at $5\ R_\odot$ it was from two sources strongly circularly polarized in opposite senses. The physical conditions inside and outside the source and the emission mechanisms are discussed. (auth)

44923 COMPARISON OF DYNAMIC RADIO SPECTRA OF THE SEPTEMBER 2, 1966 COMPLEX BURST RECORDED AT CULGOORA AND AT WEISSENAU. Urbarz, H. (Tuebingen Univ., Ger.). Solar Phys.; 13: 458-61(Aug 1970).

The dynamic radio spectrum of the event discussed by Stewart (1968) and Stewart and Hardwich (1969) was also recorded at Weissenan Observatory. The purpose of this note is to present the author's discussion with Stewart (1969). (W.D.M.)

44924 SOFT X-RAY ENHANCEMENT DURING FLARES. Deshpande, S. D.; Tandon, J. N. (Univ. of Delhi). Solar Phys.; 13: 462-6(Aug 1970).

The estimates of quiescent and flare-time temperatures of soft x-ray emitting regions on the Sun are obtained for flares observed during March–August 1967 from x-ray observations in two soft x-ray bands, 2 to 12 Å (Explorer-33 data) and 8 to 12 Å (OSO-3 data). It is concluded that hot coronal condensation, originally at 2 to 3×10^6 K, is raised to the temperature of about 4 to 5×10^6 K and is responsible for soft x-ray enhancement. (auth)

44925 SOLAR X-RAY BURSTS AND THEIR RELATION TO Hα AND MICROWAVE EMISSIONS. Harries, J. R. (Univ. of Adelaide). Solar Phys.; 13: 467-70(Aug 1970).

Solar x rays, observed by an experiment on Explorer 34, have been compared with Hα flares and microwave bursts. The x rays were detected by an xenon–methane filled proportional counter with 9.4 mg/cm^2 beryllium window of area 2.2 cm^2. (W.D.M.)

44926 PHASE OF PARTICLE ACCELERATION IN THE FLARE DEVELOPMENT. Svestka, Z. (Astronomical Inst., Ondrejov, Czech.). Solar Phys.; 13: 471-89(Aug 1970).

Evidence is given that the particle acceleration in flares is confined to the initial phase of the flare development preceding the Hα flare maximum and lasting for less than 10 min. The impulsive acceleration process is confined to a relatively small limited volume of about 5×10^{27} cm^3 in the region of highest magnetic gradient in the flare, and its size represents about 0.05 or less of the total extent of the hot condensation which produces the soft x-ray and gradual microwave bursts. About one in fifty particles in this volume is accelerated to energy exceeding 100 keV, the total particle density being $\approx 10^{10}$ cm^{-3}. The accelerated electrons produce the impulsive hard x-ray burst, but synchrotron losses greatly reduce the number of relativistic electrons participating in the bremsstrahlung process. Protons above 20 MeV penetrate to the lowest chromosphere and upper photosphere and temporarily increase the temperature in the bombarded region. As the result a flash of continuous emission appears, which should be most expressive below 1527 Å. The associated white-light emission shows the bottom of the region where the impulsive acceleration process occurs. (auth)

44927 FLUID DYNAMICS OF THIN SOLAR-WIND FILAMENTS. Siscoe, G. L. (Univ. of California, Los Angeles). Solar Phys.; 13: 490-8(Aug 1970).

The radial dependence of the flow parameters in a thin solar-wind filament corotating with the Sun is given. Presuming that the filament flow velocity is different from the external velocity close to the Sun, the solution shows that the radial component of the filament flow is eventually (at distances greater than 1 AU) brought equal to the external radial flow speed by pressures acting on the filament boundary. These pressures also induce azimuthal motion that reaches a maximum near 1 AU. The direction of the azimuthal motion is consistent with that deduced for the fast–slow stream interaction. The longitudinal angular width of the filament changes very little (≲20%) over the length of the filament. (auth)

44928 THEORETICAL AND EXPERIMENTAL STUDY OF CORONAL VISIBLE LINES FROM THE $3p^53d$ CONFIGURATION OF THE ARGON I ISOELECTRONIC SEQUENCE. Wagner, William John. Boulder, Colo.; Univ. of Colorado (1969). 179p. University Microfilms Order No. 70-5901.

Thesis.

This thesis reports the possibility that magnetic dipole transitions within the $3p^53d$ configuration of Fe IX and Ni XI may contribute to the visible spectrum of the solar corona. The energy levels of the $3p^53d$ configuration were calculated from Ca III to Cu XII using a Hartree–Fock program. Magnetic dipole and electric quadrupole transition probabilites were computed for transitions between the levels. All predicted probabilities and wavelengths were transformed into intermediate coupling. Twenty-eight magnetic dipole transitions of appreciable strength in ions Cr VII to Cu XII were predicted to lie in the visible region. A laboratory study was carried out to obtain empirical data on the $3p^53d$ configuration in high ionization stages by identifying extreme ultraviolet transitions. (TSS)

44929 X-RAY PHOTOGRAPHS OF THE SUN ON MARCH 7, 1970). Van Speybroeck, L. P.; Krieger, A. S.; Vaiana, G. S. (American Science and Engineering, Cambridge, Mass.). Nature (London); 227: 818-22(22 Aug 1970).

The sun was photographed during the eclipse on March 7th 1970 from an Aerobee rocket by means of equipment responding to the wavelength interval 3 to 60 A, revealing interesting relationships between structures in the corona. (auth) (UK)

44930 ORIGIN OF SOLAR MAGNETIC FIELDS. Parker, E. N. (Univ. of Chicago). Annu. Rev. Astron. Astrophys.; 8: 1-30(1970).

The origin and behavior of the general magnetic field of the Sun are considered. The question as to why the Sun should have any magnetic fields at all is considered, in particular, why it should have reversible polar fields and toroidal fields that migrate from high to low latitudes. The toroidal fields have opposite signs in the northern and southern hemispheres, and each successive migrating band of toroidal field has an opposite sign from its predecessor in the same hemisphere. (144 references) (W.D.M.)

44931 INTERNAL ROTATION OF THE SUN. Dicke, R. H. (Princeton Univ., N. J.). Annu. Rev. Astron. Astrophys.; 8: 297-328(1970).

Topics considered include: solar oblateness; solar oblateness and the gravitational quadrupole moment; the spindown problem and other questions of stability; solar-wind torque; evolution of the rapidly rotating core of the Sun; and lithium depletion in solar-type stars. (79 references) (W.D.M.)

44932 INTERFEROMETRIC MEASUREMENTS OF SOLAR WAVELENGTHS. O'Brien, James Edward. Washington, D. C.; Georgetown Univ. (1969). 212p. University Microfilms Order No. 70-5929.

Thesis.

The wavelengths of 157 solar absorption lines in the region 4675 to 6265 Å were determined by interferometric comparison to the standard wavelengths of ^{198}Hg. Interferograms were obtained from a Fabry–Perot interferometer crossed with a high-dispersion, Wadsworth-type spectrograph by a method similar to that used at Allegheny and Mount Wilson Observatories in the

original determinations of the I. A. U. solar wavelength standards of 1928. (TSS) (Diss. Abstr. Int., B)

44933 SIMPLE ESTIMATION OF THE SLOWING-DOWN OF FAST H ATOMS IN COLD H GAS. Schaefer, J.; Trefftz, E. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). Z. Naturforsch.; 25a: 863-7(Jun 1970). (In German).

In order to make a simple estimate of the thermalization of neutralized solar wind particles, classical elastic energy transfer cross sections are calculated for the H–H scattering process. A very simple approximation is also used for the macroscopic deceleration process. The estimated distance over which the hydrogen atoms lose half of their kinetic energy is 0.32×10^{18} cm and 24×10^{18} cm, for a starting velocity of 50 km/sec and 400 km/sec, respectively, and for interstellar hydrogen density of 0.1 cm^{-3}. It appears that generally there is no thermalization shell around a star emitting a stellar wind. (auth)

Galaxies

44934 KINEMATIC STUDY OF IONIZED HYDROGEN IN NGC 2403. Deharveng, J. M.; Pellet, A. (CNRS, Marseille). Astron. Astrophys.; 7: 210-12(Aug 1970). (In French).

Radial velocities were obtained by an interference method using the Hα line with a mean dispersion of 25 Å/mm, up to 6′ from the center. The rotation curve is in good agreement with the 21 cm data. The velocity dispersion of 28 km s^{-1} can be mainly accounted for by the velocity dispersion within the arms of the galaxy. No general Hα emission was detected. (auth)

44935 CHEMICAL ABUNDANCE OF NGC 6822. Peimbert, M.; Spinrad, H. (Univ., Mexico, Mexico City. Observatorio, Tonantzintla, Mex. Univ. of California, Berkeley). Astron. Astrophys.; 7: 311-17(Aug 1970).

By comparing the chemical abundances of a bright H II region in NGC 6822 with those of Orion and M 17, it is found that NGC 6822 is deficient in nitrogen and oxygen by factors of 6 and 1.7, respectively. The metal deficiency is consistent with the correlation of metal abundance with mass found in galaxies of the local group. The evidence for the existence of a metal abundance variation with distance to the nuclei of galaxies is rediscussed. The helium-to-hydrogen abundance ratio is very similar to that derived in the Milky Way and in other galaxies of different metal content; therefore, it is argued that most of the helium is primeval and that metal enrichment takes place at a relatively faster rate than helium enrichment in the interstellar gas. Within the accuracy of present observations, no significant helium-to-hydrogen variation as a function of distance to the nuclei of galaxies is found. (auth)

44936 STEPHAN'S QUARTET. Allen, R. J. (Kapteyn Astronomical Lab., Groningen, Netherlands). Astron. Astrophys.; 7: 330-5(Aug 1970).

Radio emission from neutral hydrogen in the Sbc galaxy NGC 7320 was detected with the radio telescope at Nançay, France. An analysis of the observed profile gives estimates of the hydrogen mass M_H (proportional to the square of the distance) and of the total mass M_T (proportional to the distance). A comparison of the ratios $(M_H/M_T - M_H)$ and M_T/L_{pg} with other Sbc galaxies whose distances are better known leads to the conclusion that NGC 7320 is most probably a dwarf system at a distance of about 10 Mpc. It is therefore unlikely that NGC 7320 is physically associated with the other four members of Stephan's Quintet (distance about 67 Mpc). The method of distance estimation used may be helpful in establishing membership of galaxies in other nearby multiple systems. (auth)

44937 UNSTABLE GROUPS OF GALAXIES. Sersic, J. L. (Observatorio Astronomico, Cordoba, Argentain). Bull. Astron. Inst. Czech.; 21: 92-5(1970).

The observed relationship between mass–luminosity ratios for groups and clusters of galaxies and their population is interpreted on the basis of a model developed by the author (1968) in which unstable groups of galaxies are thought to be the result of the fragmentation of a parent galaxy. (auth)

44938 LUNAR OCCULTATIONS OF THE GALACTIC CENTER REGION IN THE 21-cm LINE OF NEUTRAL HYDROGEN. Knowles, S. H. (Naval Research Lab., Washington, D. C.); Sullivan III, W. T. Astrophys. Lett.; 6: 21-6(Jul 1970).

Five lunar occultations of the galactic center region in the 21-cm neutral hydrogen line have been observed. No significant small angular structure was found in either the narrow feature at +6 km/sec or the general absorption extending from +15 to –15 km/sec. (auth)

44939 CHEMICAL COMPOSITIONS AND NUCLEOSYNTHESIS ON THE GALACTIC SCALE. Burbidge, E. M.; Burbidge, G. R. (Univ. of California, San Diego). Comments Astrophys. Space Phys.; 2: 92-8(May-Jun 1970).

Because of the difficulties involved in analyzing the observations of galaxies to obtain chemical compositions, the problem of interpreting integrated spectra etc., little work has been done in this field. However, the little data available are discussed, and it is shown that recent statements that the relative abundances of all of the common elements are the same in all galaxies are not correct. (W.D.M.)

44940 SUB-MILLIMETER NIGHTSKY RADIATION BACKGROUND AND ITS OBSERVABLE CONSEQUENCES ON COSMIC-RAY PHENOMENA. Cowsik, R. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett.; 6: 39-43(Jul 1970).

In an attempt to find confirmatory evidence for the existence of the strong radiation background at sub-millimeter wavelengths, its observable consequences on various cosmic-ray phenomena were examined. The existence of such a radiation background implies an enhanced hard x-ray and gamma-ray emission, from supernova remnants and from the galactic disc, through Compton scattering by relativistic electrons; and also a decrease in the mean residence time of cosmic rays with increasing energy. The present experimental data on cosmic rays are insufficient to lead to definite conclusions about the existence of the sub-millimeter radiation background. (auth)

44941 THE GALACTIC RADIO SPECTRUM: OBSERVATIONS AT 610 MHz. Howell, T. F. (Cavendish Lab., Cambridge, Eng.). Astrophys. Lett.; 6: 45-8(Jul 1970).

The galactic radio radiation at 610 MHz was observed with an antenna having the same reception pattern as that used for earlier observations at lower frequencies. A comparison of the results confirms the steepening of the galactic spectrum at frequencies above about 200 MHz but suggests that the change of slope is more gradual than was previously thought. (auth)

44942 THE RADIO SPECTRA AND BRIGHTNESS DISTRIBUTIONS OF E AND S0 GALAXIES. Heeschen, D. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett.; 6: 49-53(Jul 1970).

The radio spectra and brightness distributions of twelve nearby giant E and S0 galaxies are discussed. The galaxies display two distinctly different types of radio characteristics. One group, comprising one-half the observed galaxies, has "normal" radio spectra, with spectral indices of about –0.9. Their radio dimensions are of the same order as their optical dimensions. The second group shows a wide variety of radio spectral peculiarities and the radio emission originates in a small region in the nucleus of the galaxy. The radio characteristics of the galaxies in this second group are very similar to those of variable QSO's and radio galaxies. (auth)

44943 INSTABILITY OF GALACTIC SPIRAL DENSITY WAVES IN THE PRESENCE OF A MAGNETIC FIELD AND DIFFERENTIAL ROTATION. Ptitsina, N. G. (Astrophysical Inst., Dushanbe, USSR). Astrophys. Lett.; 5: 279-81(Jun 1970).

Spiral (and ring) density waves in an infinitesimally thin disc (and a cylinder) are unstable in the presence of a magnetic field and differential rotation. The instability is of a nongravitational nature. It may possibly lead to the increase of amplitude of spiral waves in galaxies up to observable magnitudes. (auth)

44944 FIVE-COLOR PHOTOMETRY OF SUPERGIANTS AND THE DUST-TO-GAS RATIO IN THE LARGE MAGELLANIC CLOUD. van Genderen, A. M. (Leiden Observatory). Astron. Astrophys.; 7: 49-58(Jul 1970).

A discussion is presented of photoelectric five-color observations of about 70 LMC supergiants made in 1966. Slight photometric differences between these supergiants and those in the Milky Way need further confirmation. The dust-to-gas ratio in the LMC appears to be about four times smaller than in the Galaxy. (auth)

44945 THE FREQUENCY OF SUPERNOVAE IN OUR GALAXY, ESTIMATED FROM SUPERNOVA REMNANTS DETECTED AT 178 MHz. Caswell, J. L. (Dominion Radio Astrophysical Observatory, Epping, Australia). Astron. Astrophys.; 7: 59-64 (Jul 1970).

A search for supernova remnants in the Galaxy, using a radio survey at 178 MHz, is described; from the results, the mean interval between supernova outbursts is estimated to lie between

40 and 80 years. This is compared with previous radio determinations and with the rate derived for external galaxies using optical data. In order to improve significantly the present estimate, considerably more distance determinations to individual supernova remnants are desirable. (auth)

44946 EXTENSION OF THE SAGITTARIUS-CARINA ARM FROM THREE DISTANCE H II REGIONS. Georgelin, Y. P.; Georgelin, Y. M. (Observatoire, Marseille). Astron. Astrophys.; 7: 133-40(Jul 1970). (In French).

A 4.5 × 4.5° region in Carina was studied in April 1969 at La Silla Observatory ESO with Pérot-Fabry rings. At l^{II} = 290°, radial velocities of 9 H II regions were obtained. The kinematical distances of these nebulae are spread from 3 to 9 kpc in good agreement with the spectrophotometric distances of exciting stars. This result confirms that at this longitude one is looking tangentially along a spiral arm. With these new results a more complete drawing of the Sagittarius-Carina spiral arm can be made. (auth)

44947 A NEUTRAL HYDROGEN STUDY OF THE SPIRAL GALAXY NGC 5457. Guelin, M.; Weliachew, L. (Observatoire, Meudon, France). Astron. Astrophys.; 7: 141-9(Jul 1970).

The neutral atomic hydrogen distribution and dynamics were investigated in NGC 5457 (M 101) with the Nançay radiotelescope. The resolution was 4′ in right ascension, 28′ in declination, and 59 km/s in velocity. The data were fitted by hydrogen distribution and velocity models. The hydrogen distribution presents a relative minimum in the central region and concentrations in the external region. These concentrations seem to be bound to the optical outer arms within two minutes of arc. The general hydrogen distribution is found to be strongly asymmetrical. Possible interpretations to this asymmetry are discussed. (auth)

44948 INTERSTELLAR SILICATE ABSORPTION BANDS. Hackwell, J. A. (University Coll., London. Univ. of Minnesota, Minneapolis); Gehrz, R. D.; Woolf, N. J. Nature (London); 227: 822-3(22 Aug 1970).

Interstellar silicate absorption is observed in the direction of the galactic center. Most interstellar silicon seems to be in silicate form. (auth) (UK)

44949 NUCLEI OF GALAXIES. Burbidge, G. R. (Univ. of California, San Diego). Annu. Rev. Astron. Astrophys.; 8: 360-460(1970).

The observational evidence concerning the nuclei of galaxies is reviewed and then the possible origins and evolution of galactic nuclei and the ways in which their activity bears on general galactic evolution and on cosmological problems are discussed. Topics considered in detail include: observations of the stellar and gaseous components in normal galactic nuclei; dynamics of stars and gas in normal galactic nuclei; nucleus of the Milky Way; galaxies with highly active or explosive nuclei; quasars; radio galaxies; surveys of objects with peculiar nuclei; physical conditions in Seyfert nuclei and N galaxies; objects of galactic mass ejected from galactic nuclei; uv from galactic nuclei; theory of galactic nuclei; nucleosynthesis in galactic nuclei; and galactic nuclei as general sources of particles and radiation in the Universe. (442 references) (W.D.M.)

Cosmology

Refer also to abstract 45385.

44950 POSSIBILITY OF SETTING UP REGULAR COSMOLOGICAL SOLUTIONS. Breizman, B. N.; Gurovich, V. Ts.; Sokolov, V. P. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 59: 288-94(Jul 1970). (In Russian).

A homogeneous and isotropic cosmological model is considered. The possibility is investigated of setting up regular solutions of the gravitation equations in the presence of a nonlinear correction in 4-curvature to the gravitational field Lagrangian density. An exact solution without singularities is obtained in the case when the Lagrangian density is of the form $L = A(R + \alpha R^{1/2})$. With a suitable choice of the integration constants the solution asymptotically goes over to the Friedman solution. (auth)

44951 ASYMPTOTIC ANALYSIS OF OSCILLATORY MODE OF APPROACH TO A SINGULARITY IN HOMOGENEOUS COSMOLOGICAL MODELS. Lifshits, E. M.; Lifshits, I. M.; Khalatnikov, I. M. (Inst. of Physical Problems, Moscow. Landau Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 322-36(Jul 1970). (In Russian).

An analysis of the evolution of the metric in oscillatory mode of approach to a singularity in homogeneous cosmological models is carried out in the asymptotic region of arbitrarily small times. It is shown that, in this region, successive changing of "Kasner epochs" depends in each case on a single perturbation (in other words the case never arises when two types of perturbations are operative). This permits one to carry out an analytic and statistical investigation of evolution of the model with a high degree of completeness. Recurrent formulas are derived for the oscillation periods and amplitudes during a single era (series of Kasner epochs). Formulas relating successive eras are also derived. The statistical properties of alternation of successive eras are analyzed and statistical distribution functions are obtained for the quantities characterizing the process. The probability law of increase of density of matter on approach to a singularity is found. (auth)

44952 GENERAL SOLUTION OF THE GRAVITATIONAL EQUATIONS WITH A PHYSICAL SINGULARITY OF AN OSCILLATORY NATURE. Belinskii, V. A.; Khalatnikov, I. M. (Landau Inst. of Theoretical, Moscow). Zh. Eksp. Teor. Fiz.; 59: 314-21(Jul 1970). (In Russian).

Earlier, an investigation was carried out on a general solution of the gravitation equations with the same type of time behavior as that encountered in the particular case of a homogeneous metric of Bianchi Type IX. The general solution in this case is assumed to be periodic with respect to the space variables. It is shown that, if this condition is rejected, the qualitative character of the time behavior of the general solution remains the same. Moreover, the general solution also includes as a particular case a homogeneous metric of the Type VIII along with the homogeneous metric of the Type IX. (auth)

44953 EVOLUTION OF A CHARGED SPHERE AFTER COLLAPSE UNDER A SCHWARZSCHILD SPHERE. Novikov, I. D. Zh. Eksp. Teor. Fiz.; 59: 262-6(Jul 1970). (In Russian).

Inversion of a charged sphere relativistic collapse into expansion inside a Schwarzschild sphere is considered. It was shown by Novikov (1966) that if the outer field is always a Reisner-Nordstrom field then sphere contraction will always be replaced by expansion into another outer space. It is shown here that a solution can be set up for which passage into another outer space does not occur. For this purpose one has to change the conditions in the space-time region within the Schwarzschild sphere (about which the outer observer will know nothing). Another charged sphere can be put into this region, its "explosion" changing the solution for the first sphere in such a way that passage into the other outer space will be hindered. For an observer in the first outer space the total picture of the collapse will not change and he sees an asymptotic approach of the sphere's surface to the Schwarzschild sphere. (auth)

44954 HOMOGENEOUS ANISOTROPIC MODELS WITH SHEAR IN NEWTONIAN COSMOLOGY. Shikin, I. S. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 59: 182-94(Jul 1970). (In Russian).

The problem of Newtonian analogies for homogeneous anisotropic models with shear in general relativity is considered. It has been shown by Milne and McCrea that for isotropic Friedman relativistic models there exists a close analog in Newtonian cosmology. It is shown here that within the framework of Newtonian hydrodynamics with a Newtonian gravitational potential, and under certain assumptions regarding the shear tensor structure, solutions with homogeneous deformation can be obtained that are Newtonian analogs of relativistic anisotropic models with shear of Bianchi Type I and also of Bianchi Type V in the case when transitivity hypersurfaces are orthogonal to the 4-velocity. Newtonian solutions for dust-like matter and for matter with an ultrarelativistic state equation are considered, as well as the Newtonian analog of vacuum solutions and model with a magnetic field. (auth)

44955 CLOSED UNIVERSE AND LAWS OF CONSERVATION OF ELECTRIC BARYON AND LEPTON CHARGES. Markov, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Phys. (N. Y.); 59: 109-28(Jul 1970).

As is known, the electrically charged matter excludes the closed metrics of the world. The closed world should be electrically neutral. In modern theory, baryonic and leptonic charges are treated as appropriate analogs of the electric charge. The question is discussed as to what extent this analogy is kept in the closed world. The consideration points to a possible existence of charged almost closed worlds with microscopic values of the total mass, charge and external dimensions (friedmons). According to the kind of charge, friedmons may be electrostatic, of the Yang-Mills type, ρ, φ, ω-mesonic, etc. The appropriate systems with macroscopic values of the external parameters (total mass and total charge) turn out to be unstable and after an intensive production of pairs of various kinds of particles near the horizon in strong vector fields transform into friedmons. Some effects in

the physics of assemblies of almost-closed objects (friedmons) are considered. (auth)

44956 COSMOLOGICAL AND NATURAL SCALE OF TIME IN EXPANDING MODELS OF THE UNIVERSE. Agnese, A. G. (Univ., Genoa). Lett. Nuovo Cim.; 4: 317-20(22 Aug 1970).

This letter examines the existence of a double time scale with which it is possible to describe the evolution of expanding models of the uniform Universe. (W.D.M.)

44957 MACHIAN INTERPRETATION OF GENERAL RELATIVITY. Horak, Z. (Technical Univ., Prague). Bull. Astron. Inst. Czech.; 21: 96-109(1970).

It is shown that both the general principle of relativity and Mach's principle are necessary logical consequences of the general "materialistic" postulate, saying that all physical phenomena have their origin in material objects. Thus, general relativity cannot be in contradiction with Mach's principle as some experts believe. A contradiction appears only if the cosmological term in the field equations is (without physical grounds) omitted. The complete field equations with an arbitrarily small but nonzero cosmological term are in full agreement with Mach's principle as well as the original Einstein cosmology, published in 1917, which implies that the magnitude of the cosmic potential equals the square of the light velocity. So the Einstein Universe fulfills the "Machian condition" formulated by several authors. A consequently Machian i.e., "megaphysical" conception of general relativity requires an appropriate modification of the exterior Schwarzschild solution given also in the paper. Though a static Universe seems not to be acceptable because of the generally assumed expansion of the metagalaxy yet it is possible to maintain its satisfactory features and avoid this difficulty by the hypothesis that the actual Universe consists of an immense number of oscillating "subuniverses." This quasi-static superlarge-scale version of the Einstein Universe was proposed by the author in 1968. (auth)

44958 LEMAITRE MODELS AND THE COSMOLOGICAL CONSTANT. Petrosian, V.; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Comments Astrophys. Space Phys.; 2: 109-15 (May-Jun 1070).

The possibility of a nonzero cosmological constant raises fascinating questions about the relation of its value to elementary-particle processes. However, confirmation or rejection of Lemaitre-type cosmological models will have to come from detailed observations and analyses on galaxies and quasars. At the moment the optical data on galaxies speaks against and the visual integrated intensity of observed quasars speaks for these picturesque models. (W.D.M.)

44959 THERMODYNAMICS AND COSMOLOGY. Schucking, E. L.; Spiegel, E. A. (Columbia Univ., New York). Comments Astrophys. Space Phys.; 2: 121-5(May-Jun 1970).

In studying the expansion of the Universe one usually models the problem with a perfect fluid. The fluid is assumed to expand adiabatically. When the expansion reaches a stage where gas and radiation are decoupled, it is usually assumed that for the gas $T \propto R^{-2}$, where T is the temperature of the gas and R is the scale factor. This assumption represents an approximation, but there is theoretical evidence that it is not rigorous and that even an ideal gas cannot expand adiabatically. While it is stressed that these deviations from the usual assumptions are small, it was felt that they should be discussed anyway for their "philosophical" interest. (W.D.M.)

44960 COMPANION GALAXIES CONNECTED TO NGC 772. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett.; 5: 257-60(Jun 1970).

Several smaller galaxies in the vicinity of NGC 772 are connected to this disturbed Sb spiral by luminous filaments. The redshift of NGC 772 is 2,430 km/sec. Redshifts of three of the interacting galaxies are 2,450, 20,200, and 19,700 km/sec. It is concluded that the latter two are further examples of small companion galaxies which have redshifts that do not correspond to the standard cosmological-velocity redshifts. (auth)

44961 RADIO SOURCE COUNTS FROM THE OHIO SURVEY. Harris, Beverley J.; Kraus, John D. (Ohio State Univ., Columbus). Nature (London); 227: 785-8(22 Aug 1970).

The Ohio survey shows a decrease in the number of faint sources relative to the number which would be expected for a uniform, Euclidean Universe. This confirms the results of the Cambridge 5C2 survey at 408 MHz, but the decrease is sharper for the Ohio counts at 1415 MHz. (auth) (UK)

44962 COSMIC ABUNDANCE OF HELIUM. Danziger, I. J. (Harvard Coll. Observatory, Cambridge, Mass.). Annu. Rev. Astron. Astrophys.; 8: 161-78(1970).

Up to the present time attempts to demonstrate the existence of a cosmic abundance of helium have been unsuccessful. There is probably sufficient evidence to suggest some variation of the helium abundance among different types of celestial objects, but it is by no means clear what significance should be attached to this. Local fluctuations in a relatively high underlying abundance and variations in an initially low abundance seem to be two possibilities that ought to be examined. An attempt is made to survey both the observational and theoretical results that may help to elucidate this question. (131 references) (W.D.M.)

44963 SOME APPLICATIONS OF DETAILED BALANCING. Oster, Ludwig (Univ. of Colorado, Boulder). Amer. J. Phys.; 38: 754-61(Jun 1970).

The principle of detailed balancing is used in a consistent manner to derive equilibrium distribution functions, such as the Maxwell–Boltzmann and Saha–Boltzmann distributions, and the Bose–Einstein and Fermi–Dirac distributions. The same technique is then applied to matter at very high temperatures at which radiation and elementary particles are in thermodynamic equilibrium, that is, to situations postulated in supernova explosions and the early stages of an evolutionary Universe. (auth)

Planetary Phenomena

44964 LUNAR SOIL. Wood, John A. Sci. Amer.; 223: No. 2, 14-23(Aug 1970).

A close analysis of 16 grams of soil from Apollo 11 is considered in detail. Information on the structure and early history of the Moon deducible from this analysis is discussed. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstract 44382.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 45345, 45351, and 45667.

44965 (CONF-691101–, pp 692-745) STOPPING POWER, RANGE, AND TERMINAL IONIZATION OF ANY NUCLEUS WITH 0.01 TO 500 MeV/amu IN ANY NONGASEOUS MATERIAL, INCLUDING NUCLEAR EFFECTS. Wallace, Roger; Litton, Gerald M.; Steward, Palmer, G. (California Univ., Berkeley. Lawrence Radiation Lab.).

Several methods are combined to provide the range, stopping power and Bragg peak data for any heavy ion with energy lying between 0.01 and 500 MeV per amu when incident on any nongaseous stopping medium. A Fortran IV program providing both numerical data and machine plots is available, so that any new particle or new stopping medium, whether an element or a compound, can be quickly evaluated in detail. For ions at low energy with $Z \leq 10$, the program uses experimental data. For ions with $Z \geq 10$, the nuclear and electronic stopping-power theory developed by Lindhard et al. is adjusted to fission-product range data at low energy; for intermediate energies, charge-state data developed from experimental Ar range–energy data in Al is extended to other ions and stopping media. Bethe's theory is used for all ions at high energy. Bloch's theory is discussed, although it is not used in the method. The particle ranges calculated by the method are pathlength ranges and do not include the effects of multiple scattering. Using the calculated range energy and energy loss data, a method is described to calculate Bragg curves, flux curves, and energy spectra. Energy loss from electronic and nuclear elastic collisions, nuclear attenuation, small-angle multiple scattering, straggling initial energy, and angular spreads of the beam are all taken into consideration. Contributions from secondary particles are estimated. Calculated results agree well with experimental data for those cases in which secondary-particle production is of minor importance. Even when secondaries are a large contributing factor, the method yields valuable information regarding the variation in energy deposition by the primary particles. The results are found to be quite sensitive to the degree of angular and energy spread of the initial beam. (auth)

44966 (EUR-4452, pp 401-35) SIMULATED TRANSPORT OF 2-MeV ELECTRONS IN VARIOUS MATERIALS. Patau, Jean-Paul; Blanc, Daniel; Mathieu, Jacques; Mason, Georges (Toulouse Univ. (France)). (In French).

Electron transport through matter is simulated by means of Landau, Blunck and Leisegang's energy dispersion distribution and Goudsmit and Saunderson's angular deflection distribution. The calculations give the energies deposited in depth, the slowing-down spectra, LET spectra and backscattering factor of semi-infinite media and the transmission factors for thick foils. The materials dealt with (beryllium, aluminum, Altuglass, and 2,2 4-trimethylpentane) are bombarded with a narrow beam of electrons with energies of up to 2 MeV. (auth)

44967 (EUR-4452, pp 479-92) DETERMINATION OF THE ENERGY LOSS FOR AN INELASTIC COLLISION OF FAST ELECTRONS IN WATER. Frankenberg, D. (Gesellschaft fuer Strahlenforschung, m.b.H., Frankfurt am Main (West Germany)).

The LET distribution $D(L_{100eV})$ and the experimental G-values $G_i(H)$, $G_i(OH)$, $G_i(H_2)$, and $G_i(H_2O_2)$ in 0.8N sulfuric acid for ^{60}Co gamma radiation, ^{3}H beta particles, and ^{210}Po alpha particles were used to determine the G-values $G_k(H)$, $G_k(OH)$, $G_k(H_2)$, and $G_k(H_2O_2)$ for the following three $D(L_{100eV})$ subranges $R_k(k = 1,2,3n)$: $k = 1$: $L_{100eV} < 0.8$ keV/μm; $k = 2$: 0.8 keV/μm $\leq L_{100eV} <$ 37 keV/μm; and $k = 3$: $L_{100eV} \geq 37$ keV/μm. The G-values for the subrange R_1 were used to calculate the mean energy loss of an inelastic collision. This energy loss equals 18.8 eV. (auth)

44968 (EUR-4452, pp 541-66) SPECTRUM OF ENERGY DEPOSITED BY ELECTRONS IN SPHERICAL REGIONS. Berger, Martin J. (National Bureau of Standards, Washington, D. C.).

Exploratory Monte Carlo calculations of electron transport in water were made, which are pertinent to microdosimetry. The objective of these calculations was to determine energy deposition spectra in spherical regions, i.e., the statistical distribution of the amounts of energy deposited as the result of the passage of electrons. Calculations were made for electrons with ranges comparable in magnitude to the size of the regions traversed, and the treatment therefore had to include certain phenomena disregarded in previous microdosimetry calculations. These phenomena included (a) pathlength fluctuations and detours caused by multiple elastic scattering; (b) repeated passages of the same electron through the region as the result of backscattering; (c) the transport of energy into and out of the region of secondary knock-on electrons; and (d) the contributions to the energy deposition spectra from electrons born inside the region. Numerical results are presented for electrons with an initial energy of 5 keV that deposit their energy in spherical regions with diameters of 0.2 and 1.0 microns. (auth)

44969 (EUR-4452, pp 567-94) SOME GENERAL RESULTS FROM THE TRANSPORT THEORY OF ELECTRON ABSORPTION. Harder, Dietrich (Wuerzburg Univ. (West Germany). Physikalisches Institut).

From the general transport equation in the continuous slowing-down approximation and spherical harmonics expansion, using coordinates rescaled with reference to the mean pathlength r_o, it is seen that the energy and Z dependence of the "scattering function" $S_1(t) = N r_o \sigma_1(t)[1 - P_1[\cos \Theta]$ is decisive for the whole penetration phenomenon. The properties of $S_1(t)$ are discussed in order to derive (1) three typical cases of electron absorption characterized by increase, constancy, or decrease of $S_1(t)$ during electron slowing down, and (2) a scaling law of electron absorption, according to which electron penetration phenomena are geometrically similar for equal Z (moderate energies) or for equal $Z\mu/T_o$ (high energies), the scaling factor being the mean pathlength. Several experimental observations over a wide range of energies and atomic numbers are shown to be consistent with these derivations. The screening of the nuclear Coulomb potential is of importance at low electron energies, causing backscattering and detour factors to fall off during electron slowing down. The slowing-down spectrum may be described by a simple fitted function as long as the secondary electron production is governed by the Møller cross section. This function, $N(T)/T_o = 0.17/T^{1.12}$ with T_o, T in eV, may be used to calculate the yields of radiation effects. (auth)

44970 (EUR-4452, pp 595-613) SECONDARY ELECTRON SPECTRUM BUILD-UP IN HIGH-ENERGY ELECTRON RADIATION. Schulz, H. J.; Harder, D. (Wuerzburg Univ. (West Germany). Physikalisches Institut). (In German).

Mathematical difficulties in the analytical treatment of the passage of electrons through layers of matter arise particularly when the electron deviations induced by the scatter process make an appreciable contribution to the energy loss or the decrease in the particle energy during the slowing-down process affects the scatter behavior. These difficulties also occur in the problem of secondary electron spectra behind various thick buildup layers, as the secondary electrons formed by primary particles have to reach the surface of emission from varying depths. Here the course followed in the layer may be found to be comparable with the length of the path. It is demonstrated in this case how a numerical calculation, an important element of which is a Monte Carlo calculation, leads to the desired formulation. Final results and important intermediate steps in the calculation process are compared with available experimental data. From the calculation and the experiment it is seen how when thin layers are involved the secondary electron generation characteristics (fixed energy–angle relation, Møller cross section) emerge and the formulations made in the case of thick layers cease to apply as a result of scattering and slowing down. In addition, the spectrum is levelled out to a virtually constant curve. The number of particles tends towards saturation with increasing layer thickness, and at a rate in inverse proportion to the value of the energy under consideration. (auth)

44971 (EUR-4452, pp 615-30) SPATIAL DISTRIBUTION OF DEPOSITED ENERGY ALONG THE PATH OF HEAVY CHARGED PARTICLES. Paretzke, H.; Burger, G. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz).

The spatial distribution of energy deposition along the path of heavy energetic charged particles was calculated. The results as presented demonstrate the role of delta rays in the local spread-out of energy loss. The calculations are based on a semi-analytical method proposed by Katz (Nucl. Instr. Meth., 71: 226 (1969)). Several simplifications have to be accepted in this formalism. Some problems introduced herewith and the influence of possible variations on the results are discussed. The work was done in order to investigate criteria for the preferential etchability of ion tracks in polymers based on modified LET concepts. (auth)

44972 (ORNL-4545, pp 124-37) ATOMIC AND MOLECULAR PHYSICS. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

AIR — X-ray reactions with, photoelectron spectra from
— electron reactions at 2.6 keV, auger spectra from
CROSS SECTIONS — differential, for hydrogen atom-molecule collisions at 1 keV
DEUTERIUM — reactions with molecular nitrogen, deuteron distribution from
ELECTRONS — reactions with neon and air at 3.2 keV, K auger spectra from
— reactions with molecular hydrogen at 1.5 keV, proton distribution from
ELECTROSTATIC ANALYZERS — design for particle energy distribution measurements in atomic and molecular collisions
HYDROGEN — electron reactions with molecular 1.5 keV, proton distribution from
— reactions with molecular nitrogen, proton distribution from
— reactions with molecular hydrogen at 1 keV, differential cross sections for
NEON — electron reactions at 3.2 keV, K auger spectra from
— photon reactions at 1.5 keV, K auger spectra from
— X-ray reactions with, photoelectron spectra from
NITROGEN — hydrogen reactions with molecular, proton distribution from
— deuterium reactions with molecular, deuteron distribution from
PHOTONS — reactions with neon at 1.5 keV, K auger spectra from
PLASMA — ion energy losses in, Coulomb logarithm for test
X RADIATION — reactions with neon, photoelectron spectra from (M.O.W.)

44973 (UCLA-ENG-7061) SCATTERING OF ARGON BEAMS WITH INCIDENT ENERGIES UP TO 20 eV FROM A (111) SILVER SURFACE. Hays, William Joseph (California Univ., Los Angeles. School of Engineering and Applied Science). Jul 1970. 118p.

A helium–argon mixture is arc-heated, expanded in a free jet, and collimated to form a nearly monoenergetic beam with argon energies up to about 20 eV per atom. A (111) silver surface (at least initially relatively uncontaminated) is prepared by epitaxially depositing silver vapor on a mica substrate maintained at about 300°C. The incident beam is characterized using time-of-flight techniques. The surface is characterized in situ by observing the angular distribution of a room-temperature helium beam scattered from the surface. The appropriate species is detected using a quadrupole mass spectrometer. (A new method is presented for removing the electronic distortion of the detection system from the detected signal.) The argon scattering distribution is determined to be a specularly directed single lobe. It is found that bombarding the surface with a relatively high-energy argon beam reduces significantly the width of the scattering distribution realized for the probing room temperature helium beam. (auth)

44974 THE MEAN VELOCITY OF PARTICLES EJECTED FROM A POLYCRYSTALLINE COPPER SURFACE DURING THE

BOMBARDMENT WITH HIGH-ENERGY Ar^+ IONS. Krueger, W.; Scharmann, A. (Univ., Giessen, Ger.). Z. Phys.; 237: 263-71 (1970).

The measurements were made with the aid of a sensitive ballistic microbalance. The mean velocity decreased rapidly above 150 keV with increasing energy and reached a constant value at about 800 keV. The exact analysis of the motion of the balance exhibits a strong influence of condensation phenomena and of the bombarding ions on the experiments. (auth)

44975 FREQUENCY DISTRIBUTIONS OF ENERGY DEPOSITION BY FAST CHARGED PARTICLES IN VERY SMALL PATHLENGTHS. Baily, Norman A.; Steigerwalt, John E.; Hilbert, Jerald W. (Univ. of California, San Diego, La Jolla). Phys. Rev., B; 2: 577-82(1 Aug 1970).

The frequency distribution of energy losses in an equimolar mixture of $He-CO_2$ by 46.4-MeV protons has been examined experimentally and compared with the distributions predicted by the Blunck–Leisegang-corrected Vavilov theory. The distributions studied correspond to mean energy losses of 1.56, 7.85, and 15.6 keV. The theoretical predictions of the distributions with the larger mean energy losses agree well with the experimental data in the region about the most probable energy loss. However, agreement between the values of the measured and predicted full widths at half-maximum of the distribution found for a mean energy loss of 1.56 keV is not as good as for the other distributions. This is due partly to a larger uncertainty in the experimental parameters of the calculation. Considerable disagreement exists when theory and experiment are compared in regions of high and low energy losses for all of the distributions. (auth)

44976 SECONDARY-ELECTRON EMISSION AFTER REFLECTION BY FISSION FRAGMENTS AND alpha PARTICLES. Daukeev, D. K.; Lebedev, S. Ya. Sov. Phys.-Solid State (Engl. Transl.); 12: 507-8(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 655-6(Feb 1970).

The secondary electron spectrum from ^{252}Cf fission fragments and alpha particles passing through a thin target of Al_2O_3 with an Al film deposited on it, was measured using the reflection mode. Both angular dependence and energy spectra were measured. The spectra of the transmission and reflection experiments were found to overlap in the soft region, but in the hard part of the spectrum, the transmission spectrum is greater due to nonthermalized ∂ electrons. The most probable energy is ~0.8 eV, and the angular dependence obeys the cos θ law. (D.L.C.)

44977 IONIC COMPONENT OF CATHODIC SPUTTERING OF A COPPER SINGLE CRYSTAL. Bukhanov, V. M.; Yurasova, V. E.; Sysoev, A. A.; Samsonov, G. V.; Nikolaev, B. I. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 12: 313-15 (Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 394-7(Feb 1970).

An investigation of the angular and energy distributions of secondary positive ions, ejected from the (100) face of copper by 5- and 30-keV neon ions, is reported. (auth)

44978 SECONDARY EMISSION FROM WATER UNDER ELECTRON BOMBARDMENT. Collet, Luc-Henry; Lemperiere, Georges (Nantes Univ., France). Compt. Rend., Ser. B; 270: 1532-5(15 Jun 1970). (In French).

The secondary emission from water bombarded by an electron beam is studied. An interpretation of the results is given, taking into account the high vapor pressure of the target. (auth) (France)

44979 STUDY OF AN ION SOURCE OPERATING BETWEEN 2 AND SEVERAL HUNDREDS eV. Devienne, F. Marcel; Roustan, J. C. (Laboratoire de Physique Moleculaire de Haute Energie, Peymeinade, France). pp 549-57 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The source was built to produce and study the neutral particle beams generated from complex ions. The plasma is derived from impact of an electron beam. Measurement indicates a small energy spread in the ion beam. (auth) (France)

44980 INFLUENCE OF THE ION ENERGY ON SPUTTERING YIELDS IN THE NEAR-THRESHOLD REGION. Askerov, Sh. G. (Azerbaydzhan State Univ., Baku). Sov. Phys.-Solid State (Engl. Transl.); 12: 513(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 660-1(Feb 1970).

The sputtering yield of single crystals is linearly dependent on ion energy, while that of polycrystalline targets is not. A qualitative explanation of this effect is offered, in which the bombarded surfaces of the polycrystalline targets are shown to consist of different faces with varying sputtering thresholds. (D.L.C.)

44981 EMISSION SPECTRUM FROM ALPHA-IRRADIATED NITROGEN. Brunet, Henri; Galy, Jacques; Millet, Pierre; Salamero, Yves (Univ., Toulouse). Compt. Rend., Ser. B; 270: 1473-6(8 Jun 1970). (In French).

The band heads in the emission spectra of α-irradiated nitrogen, at a pressure of a few hundred torr, were identified. The ratio of the non-radiative, and the radiative de-excitation were determined for the O–O transition of the 1st negative system of N_2^+, and for the second positive system of N_2 from the variation of the ratio of the intensities at the heads of the corresponding bands as a function of pressure. (tr-auth) (France)

44982 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 5, NO. 5, 1970. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main: Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 46p.

This listing includes 186 articles on various aspects of the subject. (M.O.W.)

44983 TEMPERATURE EFFECT ON ENERGY-LOSS SPECTRUM OF FAST ELECTRONS IN ALUMINUM AND LEAD FOILS BETWEEN 3 AND 295°K. Imbusch, A.; Niedrig, H. (Technische Univ., Berlin). Phys. Lett., 32A: 375-6(24 Aug 1970).

The temperature dependence of the characteristic energy losses of fast electrons traversing thin films of Al and Pb was investigated. Special efforts were made to detect any change in the energy loss spectrum of the Pb films at the transition into the superconducting state. (auth)

44984 SECONDARY ELECTRON EMISSION FROM MONOCRYSTALLINE SILICON UNDER ION BOMBARDMENT. Fontbonne, Jean-Pierre; Colombie, Nicole; Fagot, Bernard (Toulouse Univ.). Compt. Rend., Ser. B; 270: 1573-6(15 Jun 1970). (In French).

The coefficient of electron secondary emission for monocrystalline silicon targets under rare gas ion bombardment (20 to 100 keV) is studied. The measurements were made at sufficiently high temperature to ensure the restoration of the crystalline structure. (tr-auth) (France)

44985 COMPUTER SIMULATION OF SPUTTERING. Ostry, D.; MacDonald, R. J. (Australian National Univ., Canberra). Phys. Lett.; 32A: 303-4(10 Aug 1970).

A brief description of the preliminary results of the computer simulation of the sputtering of single crystals of Ge with 1-keV Ar^+ ions is presented. The simulation reproduces experimental ejection patterns very well. Focussing events are not observed to contribute to the ejection pattern. All sputtered atoms are the result of collisions similar to those described in previous simulation experiments on Cu. (auth)

44986 OBSERVATIONS OF ENERGY LOSS PROCESSES USUALLY MASKED BY PLURAL SCATTERING OF FAST ELECTRONS. Crick, R. A.; Misell, D. L. (Queen Elizabeth Coll., London). Nature (London); 227: 484-5(1 Aug 1970).

The technique of electron energy-loss analysis has application in the study of electronic energy levels of solids and in microanalysis using energy-analyzing electron microscopes. Plural scattering of fast electrons (20 to 100 keV) in thin films, however, gives rise to spectral lines related to the basic excitation processes and occurring at approximately integral multiples of these loss processes; multiple losses cannot always be distinguished from the primary loss lines. Plural scattering effects can also mark excitations of low probability. The electron energy-loss spectrum from evaporated Ge films is cited as an example. The 15.6-eV plasma loss and its multiples obscure the $M_{4,5}$ x-ray absorption edge at 32 eV, but it is shown that the energy spectrum of Ge may be corrected for these plural scattering effects, revealing structure in the spectrum at 33 eV. It is concluded that electron energy analysis using the described procedure could prove a useful technique for spectral analysis and microanalysis where plural scattering effects made interpretation of such spectra analysis ambiguous. The alternative of using very thin films in order to minimize the effects of plural scattering is unsatisfactory because of the effects of surface contamination and oxidation with metallic specimens. (UK)

44987 CHARACTERISTIC ELECTRON ENERGY LOSS SPECTRA FOR OSMIUM. Zashkvara, V. V.; Korsunskii, M. I.; Larin, M. P.; Red'kin, V. S.; Masyagin, V. E.; Kil'diyarov, M. A.; Chokin, K. Sh. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 238-9(Jul 1970).

Translated from Fiz. Tverd. Tela: 12: 294-6(Jan 1970).

Electron energy loss spectra were obtained by reflection of an electron beam from a plane surface of an Os specimen, using two scattering angles at 141° and 39°. From the spectra, the position of the first energy loss at 11.4 eV does not vary with angle. Possible surface and bulk plasma oscillations are considered. (D.L.C.)

44988 STATISTICAL SCATTER OF THE RANGE OF HEAVY, CHARGED PARTICLES. Kessel'man, V. S.; Bulgakov, Yu. V. At. Energ. (USSR); 28: 173-4(Feb 1970). (In Russian).

As a result of the statistical fluctuations of inelastic energy losses and elastic collisons, the range of charged particles possessing an identical initial energy E exhibits values scattered around a mean value $\bar{R}$. The scatter is asymmetric with respect to the mean value and the most probable range does not agree with the mean calculated one. This asymmetry was studied, determining the "bias" coefficient S_k. It was found that in the high-energy range, in which inelastic "electronic" energy losses prevail, the value of S_k is much less than 1 and the shape of the range distribution curve approaches Gaussian values. The effect of multiple collisions was neglected but in future work it will be taken into account. (TTT)

44989 CHARGE EXCHANGE CROSS-SECTIONS OF PROTONS IN SOLID MATERIALS. Acerbi, E.; Birattari, C.; Candoni, B.; Castiglioni, M.; Dutto, G.; Fait, G.; Succi, C. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Lett. Nuovo Cim.; 3: 827-30(27 Jun 1970).

Proton beams having energies from 20 to 43 MeV were passed through solid targets of Al, Ag, Au, Pb, and Moplefan $(C_3H_4)_n$, and the ratio of neutral to positive particles in the emerging beam was measured. From these values, cross sections for electron capture were calculated. Agreement with theoretical values was considered to be satisfactory. (A.G.W.)

44990 SMALL-ANGLE SCATTERING OF ELECTRONS IN THIN FILMS OF EVAPORATED CARBON. Burge, R. E.; Misell, D. L.; Smart, J. W. (Queen Elizabeth Coll., London). J. Phys., C (London); 3: 1661-72(Aug 1970).

A detailed study was made of small-angle (1×10^{-4} to 8×10^{-3} radian) electron scattering in thin films of evaporated carbon (film thickness range 50 to 1480 Å) for a series of incident electron energies (30 to 80 keV). The angular distribution of the electrons scattered in such films was interpreted in terms of plural scattering of the incident electrons within the specimen film. The plural scattering calculations were based on both the free atom theory and the Bohm–Pines plasma oscillation theory. The two sets of theoretical calculations both agree with experiment to within a deviation of 20% for angles of scattering in the range 5×10^{-4} to 5×10^{-3} radian and for films thinner than about 1000 Å. (auth) (UK)

Atomic and Molecular Properties

Refer also to abstracts 44928, 45346, and 45379.

44991 (NBS-SPEC. PUBL-306-1) BIBLIOGRAPHY ON THE ANALYSES OF OPTICAL ATOMIC SPECTRA. SECTION 1. ^{1}H–^{23}V. Moore, Charlotte E. (National Bureau of Standards, Washington, D. C.). Sep 1968. 79p. GPO $1.00.

References needed for the preparation of revised tables of atomic energy levels and multiplets are listed. They are essentially references that deal with the outer structure of atoms as revealed by their spectra. Most references refer to laboratory analyses but a few refer to observations of nebular or coronal spectra. A limited number of general references precedes listings under individual elements. The time interval covered is that since publication of NBS Circ. 467, "Atomic Energy Levels" (1949). (A.G.W.)

44992 Z-EXPANSION CORRECTIONS TO THE LANDE INTERVAL RULE. Snyder, R. (Queen's Univ., Belfast). J. Phys., B (London); 3: L77-9(Jul 1970).

It is shown that the relativistic Z-expansion theory predicts a deviation D/Z from the Landé value of $J/(J-1)$ for the interval ratio $(^{2S+1}L_J - {}^{2S+1}L_{J-1})/({}^{2S+1}L_{J-1} - {}^{2S+1}L_{J-2})$ in the limit of LS coupling. The exact values of D are shown to be 8.5333, 1.1250 and −1.5018 for the He I-like $1s2p\ {}^3P$, Be I-like $1s^22s2p\ {}^3P$, and B I-like $1s^22s2p^2\ {}^4P$ multiplets respectively. These values are shown to be in agreement with experiment. (auth) (UK)

44993 RADIATIVE TRANSITION PROBABILITIES FOR VACANCIES IN M SUBSHELLS. Bhalla, C. P. (Kansas State Univ., Manhattan). J. Phys., B (London); 3: 916-24(Jul 1970).

Numerical results for the radiative transition probabilities are presented when a vacancy exists in an M subshell over a wide range of atomic numbers. The relativistic Hartree–Fock–Slater atomic model is used. (auth) (UK)

44994 LAMB SHIFT WITH CIRCULARLY POLARIZED rf FIELD IN FOIL-EXCITED H BEAM. Andra, H. J. (Univ. of Arizona, Tucson). Contract F33615-70-C-1007. Phys. Lett.; 32A: 345-6(10 Aug 1970).

Beam-foil-excited H atoms were used to measure time- and rf-power-dependent H- (n = 2) Lamb-shift resonance shapes with a circular polarized rf-field. (auth)

44995 VARIATIONAL UPPER AND LOWER BOUNDS FOR STOPPING POWERS OF ATOMS AND MOLECULES. Yur'ev, M. S. (Univ. of Leningrad). Chem. Phys. Lett.; 6: 172-4 (1 Aug 1970).

A variational procedure for calculating upper and lower bounds for the logarithm of the average energy of excitation ln I in the theory of the stopping power of atoms and molecules is described. The upper and lower bounds for ln I of the hydrogen atom are calculated. (auth)

44996 SOLUTION OF THE HARTREE–FOCK FIRST-ORDER EQUATION FOR THE HELIUM ATOM. Winter, Nicholas W. (Battelle Memorial Inst., Columbus, Ohio); McKoy, Vincent; Laferriere, Arthur. Chem. Phys. Lett.; 6: 175-9(1 Aug 1970).

The first-order equation for the ground state of the helium atom was solved numerically. The perturbation energies and several one-electron properties are presented and compared to variational results. Since the method is not variational, the first-order solutions for excited states can be obtained easily with this approach. (auth)

44997 DISSOCIATION ENERGY OF THE HYDROGEN MOLECULE USING LONG-RANGE FORCES. Stwalley, W. C. (Univ. of Iowa, Iowa City). Chem. Phys. Lett.; 6: 241-4(1 Aug 1970).

New assignments of vibrational levels near dissociation in the $B^1\Sigma_u^+$ state of H_2 indicate the vibrational quantum number is proportional to the one-sixth power of the binding energy, as expected theoretically from the long-range r^{-3} behavior of the internuclear potential. This is used to obtain an improved dissociation limit of 118377.7 ± 0.5 cm^{-1}, corresponding to a ground-state $(X^1\Sigma_g^+)$ dissociation energy $D_0^0 = 36118.6 \pm 0.5$ cm^{-1}. (auth)

44998 INFLUENCE OF LAMB SHIFT ON INTERFERENCE OF EXCITED STATES OF HYDROGEN ATOMS. Sokolov, Yu. L. JETP Lett. (USSR) (Engl. Transl.); 11: 359-62(5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 524-8 (5 Jun 1970).

In preliminary experiments performed principally for the purpose of observing interference of certain excited states of the H atom, a beam of metastable $2s_{\frac{1}{2}}$ atoms of H with energy ~20 keV was passed through a special capacitor with an abrupt change of the field on the edges. The flux of the $2p_{\frac{1}{2}}$ atoms produced was measured. Plots of the yield of the 2p component as a function of field intensity show that the influence of the Lamb shift is pronounced and that it consists of a gradual increase in amplitude and a gradual decrease in period with increasing field intensity. (A.G.W.)

44999 EXPERIMENTAL OBSERVATIONS OF THE PROFILES AND RELATIVE INTENSITIES OF He I 2^3P-4^3D (λ4471) AND 2^3P-4^3F (λ4470) AT LOW ELECTRON DENSITIES. Burgess, D. D.; Cairns, C. J. (Imperial Coll. of Science and Tech., London). J. Phys., B (London); 3: L67-70(Jul 1970).

Accurate profiles of the astrophysically important He I 4471-Å transition and its associated forbidden component were obtained for the first time in a laboratory plasma of independently known electron density at electron density values comparable to those in B-class stars. Comparison of the experimental profiles with the most recent and accurate theoretical predictions shows very good agreement for the halfwidth and profile of the allowed component and for the profile of the far wing of the forbidden component, but a very considerable discrepancy exists between theoretical and experimental values of the intensity near the peak of the forbidden component. (auth) (UK)

45000 SOME COMMENTS ON PRESENT THEORETICAL CALCULATIONS OF THE PROFILES OF FORBIDDEN COMPONENTS IN THE WINGS OF STARK-BROADENED SPECTRAL LINES. Burgess, D. D. (Imperial Coll. of Science and Tech., London). J. Phys., B (London); 3: L70-4(Jul 1970).

Objections are raised to the basic theoretical validity of all previous calculations of the intensities and profiles of optically forbidden transitions induced by the electric microfield in a plasma. These theoretical objections are relevant in the case of neutral helium lines at the densities of interest in early-

type stars when such forbidden components are strongly excited. They also relate to the discrepancy between theory and experiment reported in the preceding experimental letter. (auth) (UK)

45001 THEORETICAL MODEL FOR THE INTERACTION BETWEEN EXCITED AND GROUND STATE ATOMS. APPLICATION TO PRESSURE BROADENING. Roueff, E. (Observatoire, Meudon, France). Astron. Astrophys.; 7: 4-9(Jul 1970).

A theoretical model for the long-range interaction between excited- and ground-state atoms is derived after a paper from Smirnov (1967) in a more reliable form. This interatomic potential is described in terms of physical data like polarizability and scattering length of the perturbing atom and of the probability of presence of the valence electron at the internuclear distance. Applications have been made to pressure broadening of sodium and cesium lines by helium. The comparison with existing experimental results gives a good fitting within the experimental range of accuracy. The very long-range van der Waals potential is found to have little effect so that the range of the interaction is shorter and adequately represented by the hypothesis. Calculations concerning pressure broadening due to hydrogen are in progress. (auth)

45002 STERNHEIMER R FACTOR. Pollak, H.; Remy, P. H. (Univ., Lovanium, Kinshasa, Congo). pp 439-43 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Formulae are presented for calculation of the Sternheimer R shielding factor with allowance for exchange effects. (auth)

45003 MOLECULAR FORMATION AND ELECTRON CORRELATION IN HeH^+. Banyard, K. E.; Baker, C. C. (Univ. of Leicester, Eng.). Int. J. Quant. Chem.; 4: 431-50(Jul 1970).

A one-center CI wave function for HeH^+ reported by Stuart and Matsen for $0.1 \leq R \leq 5.0$ was analyzed in detail from the viewpoint of molecular formation. Further, by means of a natural orbital analysis, it was possible to obtain some measure of the electron correlation contained within such wave functions for various R values. These effects were illustrated by means of a series of difference maps for the electron density. One- and two-particle expectation values were obtained as a function of R. Thus, it was possible to study several aspects of the influence of the proton on the electron charge cloud in passing from He through to the united atom Li^+. The occupation numbers within the natural expansions were compared with those arising from a similar analysis of a two-center wave function for HeH^+. The "character" of such wave functions for HeH^+, and also for He and Li^+, were analyzed and compared. (auth)

45004 HYDROGEN STARK BROADENING CALCULATIONS WITH THE UNIFIED CLASSICAL PATH THEORY. Vidal, C. R.; Cooper, J.; Smith, E. W. (National Bureau of Standards, Boulder, Colo). Contract DA-31-124-ARO-D-139. J. Quant. Spectrosc. Radiative Transfer; 10: 1011-63(Sep 1970).

The unified theory was generalized for the case of upper and lower state interaction by introducing a more compact tetradic notation. The general result was then applied to the Stark broadening of hydrogen. The thermal average of the time-development operator for upper and lower state interaction is given. Except for the time ordering it contains the effect of finite interaction time between the radiator and perturbers to all orders, thus avoiding a Lewis-type cutoff. A simple technique for evaluating the Fourier transform of the thermal average was developed. The final calculations based on the unified theory and on the one-electron theory are compared with measurements in the high and low electron-density regime. The unified theory calculations cover the entire line profile from the line center to the static wing and the simpler one-electron theory calculations provide the line intensities only in the line wings. (auth) (UK)

45005 CALCULATION OF THE INDIRECT NUCLEAR SPIN–SPIN COUPLING CONSTANT OF THE HYDROGEN MOLECULE BY THE TRUNCATED MATRIX SUM METHOD. Emanuel, R. V. (Univ. of Glasgow). Mol. Phys.; 19: 399-403(Sep 1970).

The hydrogen-molecule coupling constant was calculated from the second-order perturbation theory summation expression of Ramsey (Phys. Rev. 91: 303(1953)), truncated after the first few terms. The most accurate available wave functions, those of the James–Coolidge type (J. Chem. Phys. 1: 825(1933) and 6: 730 (1938)), give a value for the coupling constant of about 163 Hz compared with the experimental value of 278 Hz. Values of the largest discrete term (the first term) calculated from various approximate wave functions vary widely. In particular, the calculation analogous to the usual molecular orbital calculation gives a value of 726 Hz for the first term (compared with 199 Hz calculated from James–Coolidge type wave functions). (auth) (UK)

45006 DETERMINATION OF ELECTRON BINDING ENERGIES. Logan, Brian A. (Univ. of Ottawa). Amer. J. Phys.; 38: 1248-9(Oct 1970).

An experimental method is described for measuring the binding energies of K and L shell electrons in heavy elements. A beam from a radioactive source is defined by a tungsten collimator and enters a brass enclosure through a thin plastic window. The enclosure is evacuated to a pressure below 10^{-4} torr and contains a thin photoelectric target and a lithium-drifted silicon detector mounted on a copper bar. The copper bar projects out of the enclosure into a liquid nitrogen container. In order to reduce heat conduction, the copper bar is connected to the brass enclosure by a thin stainless-steel section. Electrons emitted from the target are detected in the silicon counter, and after amplification by a conventional preamplifier amplifier system, the spectrum is recorded in a multichannel analyzer. Diagrams of the apparatus and the electronic arrangement are given. (M.O.W.)

45007 RADIATIVE LIFETIMES FOR THE $2p\pi^3\Pi_u$ STATE OF THE HYDROGEN MOLECULE. Freis, Robert P.; Hiskes, John R. (Univ. of California, Livermore). Phys. Rev., A; 2: 573-80(Sep 1970).

A calculation is made of the radiative electric dipole transition probabilities coupling the vibrational levels of the $2p\pi^3\Pi_u$ and the $2s\sigma^3\Sigma_g$ electronic states of hydrogen. The radiative lifetimes for those vibrational levels lying above the ground state are found to be approximately 100 μsec. The lifetime of the ground vibrational level, decaying by magnetic dipole and electric quadrupole emissions, is estimated to be 1 msec. Finally, a calculation is made of the dependence of the radiative lifetimes upon an external electric field. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 45312.

45008 CHEMICAL SHIFTS OF THE μ^+. Breskman, D.; Kanofsky, A. (Lehigh Univ., Bethlehem, Pa.). Nuovo Cim.; 68B: 147-52(11 Aug 1970).

The determination of μ-molecule formation by measurement of the μ^+ precession frequency shifts in a magnetic field (due to chemical shifts) is proposed. The differences in chemical shifts between a muon and a proton in simple halide molecules are calculated and shown to be about 2 ppM. A formula, based on the shift of the μ^+ precession frequency, is presented for determining reaction rates for μ-molecule formation. (auth)

45009 FORMATION OF POSITRONIUM NEGATIVE IONS IN POSITRONIUM–HYDROGEN COLLISIONS. Stancanelli, A.; Ferrante, G. (Univ., Messina, Italy). Nuovo Cim.; 68B: 137-46 (11 Aug 1970).

The total cross section for positronium negative-ion formation in positronium–hydrogen collisions is calculated, using the Born approximation and some simplifying assumptions, for positronium energies up to 90 eV. The maximum value of the cross section is estimated to be about 0.09 πa_0^2 and occurs at the positronium energy of 21 eV. Comparisons with other calculations are also reported. In particular, comparison with the available calculations on ortho–para conversion of positronium shows that at energies greater than 20 eV, positronium ion formation may become a competitive process. Further, it is suggested that positronium ion formation in positronium–hydrogen collisions may serve as a positronium quenching mechanism. (auth)

45010 USE OF POSITRON-EMITTING RADIATION SOURCES IN THE STUDY OF ELECTRON MOMENTA IN SOLID AND FLUID STATES. Gacii, P. (University Coll., Nairobi, Kenya). pp 487-97 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

It is shown how information about the momentum and energy distribution inherent in electronic systems of solids and liquids can be extracted from gamma angular correlation studies in positron annihilation. Actual results are given for liquid helium and the plastic scintillator NE102. In the simple case of helium, experimental results agree with experimental calculations; thus, it is felt that the experimental technique can be justified for study of electron momenta in more complicated systems. (L.M.T.)

45011 LIFETIME OF POSITRONS TRAPPED BY F-CENTERS IN KCl. Dupasquier, A. Politecnico, Milan. Consiglio Nazionale delle Ricerche, Milan). Lett. Nuovo Cim.; 4: 13-15(4 Jul 1970).

Experiments are described on the lifetime distribution of positrons annihilating in nonstoichiometric KCl single crystals colored by F centers in concentrations of the order of 10^{17} centers/cm^3. Positron lifetime spectra are measured both for additively and electrolytically colored KCl. (M.O.W.)

45012 A METHOD OF AN ATTEMPT TO DETECT THE LYMAN-α RADIATION FROM POSITRONIUM. Fagg, L. W. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 85: 53-9(1 Aug 1970).

The experimental apparatus and the procedure used in an unsuccessful attempt to detect the Lyman-α radiation from the positronium atom are described. The essential feature of the technique is the isolation of the desired event by means of a "quadruple" coincidence between the Lyman-α photon and the three ortho-positronium annihilation quanta. The results are discussed along with suggestions for improvements for future attempts. (auth)

Collision Phenomena

Refer also to abstracts 44263 and 44933.

45013 (CEA-N-1259) LOGICAL AND MATHEMATICAL SCHEME FOR THE DIGITAL CALCULATION OF THE CROSS SECTIONS OF INELASTIC ELECTRON SCATTERING BY THE PHASE SHIFT METHOD. Bardin, Christian; Dandeu, Yves; Samour, Jean-Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1970. 42p. (In French). Dep. CFSTI (U. S. Sales Only).

The treatment was made according to the following plan: the transformation of the expression of the cross sections $\sigma_e(\theta)$ and $\sigma_m(\theta)$ was made. The series giving $\Sigma^{II}_{LM}(\theta)$ and $\mu^{II}_{LM}(\theta)$ were calculated and their convergence was studied. A general flow chart was given and numerical methods were proposed. The flow chart was then examined in detail. (tr-auth) (France)

45014 (EUR-4452, pp 493-510) THE VARIATION OF W WITH THE ENERGY OF HEAVY IONS. Dennis, J. A. (Atomic Energy Research Establishment, Harwell (England)).

W values for carbon and oxygen ions in carbon dioxide were calculated as a function of energy. The calculation is based on the scattering cross sections of atoms for ions derived from the Thomas-Fermi atomic model by Lindhard, Scharff, and Schiøtt. It is assumed that such scattering does not lead to ionization. The interaction of a heavy ion with electrons is assumed to result in a stopping power proportional to the ion velocity and to always lead to the same ionization efficiency. The calculation is taken to successively higher degrees of approximation corresponding to primary, secondary, tertiary, etc., atomic displacements. Owing to the rapid convergence, a fifth degree of approximation appears to be sufficient. A reasonable degree of agreement with experiment is observed. (auth)

45015 (EUR-4452, pp 511-28) QUANTUM MECHANICAL BOUND STATE CORRECTIONS TO THE $1/E^2$ COLLISION SPECTRUM. Bichsel, Hans (Washington Univ., Seattle).

In calculations concerning the interaction of heavy charged particles of velocity v with atoms, it is often assumed that the spectrum J of energy losses E of incident particles can be described by the classical result $J = k/E^2$ with $E_{min} < E < 2mv^2$ (low-energy approximation). This is not an accurate representation of the spectra expected in experimental observations. A considerably better approximation can be obtained from calculations with the first Born approximation, using hydrogenic atomic wave functions. Results of such calculations are presented. Several concepts useful in many applications can now be understood simply (number of collisions in a thin foil, energy loss, etc.). These concepts are discussed, and corrections necessary in the classical formalism are shown. (auth)

45016 (ORNL-4556) TABLES OF CLASSICAL SCATTERING INTEGRALS. Robinson, Mark T. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 168p. Dep. CFSTI.

Values of the apsis, the barycentric scattering angle, the relative transferred energy, the "time integral," and the differential scattering cross section are tabulated as functions of the impact parameter and the relative kinetic energy for each of four interatomic potential functions. Classical mechanics was used throughout the calculations. The potentials used are the Born-Mayer (exponential), the Bohr (exponentially screened Coulomb), and the Molière and Sommerfeld approximations to the Thomas-Fermi potential. These tables are a revised and greatly extended edition of an earlier tabulation, ORNL-3493 (1963). Auxiliary tables compare the Molière and Sommerfeld approximations with the Thomas-Fermi screening function and the effects on the tabulated integrals of alterations in the quadrature procedure. (auth)

45017 LOW-ENERGY ELECTRON SCATTERING BY Mg I. Van Blerkom, J. K. (Joint Inst. for Lab. Astrophysics, Boulder, Colo. Univ. of Colorado, Boulder). J. Phys., B (London); 3: 932-6(Jul 1970).

The electron collisional cross sections for the three lowest states of Mg I are calculated using the close-coupling approximation with a semi-empirical core potential. Configuration interaction is included in the Mg I wave functions. Several resonances occur, a few of which strongly affect the total cross sections. Three elastic cross sections (3^1S-3^1S, 3^3P-3^3P, and 3^1P-3^1P) and three inelastic cross sections (3^1S-3^3P, 3^1S-3^1P, and 3^3P-3^1P) are presented. (auth) (UK)

45018 DIFFERENTIAL CROSS SECTIONS FOR IONIZATION OF ATOMIC HYDROGEN AND HELIUM BY ELECTRON AND PROTON IMPACT. Bell, K. L.; Freeston, M. W.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B (London); 3: 959-70(Jul 1970).

The classical impulse approximation to the differential cross sections for electron and proton ionization of atomic hydrogen and helium are calculated using accurate electron velocity distributions for the atoms. The results are compared with quantal Born calculations. It is shown that the classical impulse and quantal Born differential cross sections agree over a wide range of energies of both the incident and ejected particles. If the energies of the incident and ejected particles are both large it is proved that the classical impulse, Thomson, and Born approximations will all give the same differential cross sections for ionization of atomic hydrogen. For proton ionization of helium the classical impulse gives differential cross sections that agree quite well with measurements. (auth) (UK)

45019 EXCITATION OF THE HELIUM S LEVELS BY HYDROGEN IMPACT. Crothers, D. S. F. (Queen's Univ., Belfast); McEachran, R. P. J. Phys., B (London); 3: 976-90(Jul 1970).

The cross sections for $H(1s) + He(1s^2\ ^1S) \rightarrow H(\Sigma) + He(1snsn\ ^{1,3}S)$, where n = 2, 3, 4, 5, or 6, are calculated to first order, with allowance for projectile ionization and projectile-target-electron exchange within the Ochkur-Rudge approximation, as previously described by Bates and Crothers (1967). Accurate helium transition integrals are obtained analytically using Hartree-Fock frozen-core wave functions. There is quite good accord between the calculated 3^3S and 4^3S cross sections and the measured values of Van Eck, de Heer and Kistemaker (1964). A discrepancy is noted between the fall-off with respect to energy of the calculated 4^1S cross section and that of the cross section measured by Robinson and Gilbody (1967). It is suggested that this may be due to neglect of coupling effects. Where appropriate, comparison is made with both proton and electron impact. (auth) (UK)

45020 ELECTRON-IMPACT THRESHOLD EXCITATION OF N_2 BY THE TRAPPED-ELECTRON METHOD. Hall, R. I.; Mazeau, J.; Reinhardt, J.; Schermann, C. (Laboratoire de Physique et Optique Corpusculaires, Paris). J. Phys., B (London); 3: 991-8(Jul 1970).

The threshold excitation spectrum of N_2 by electron impact in the 6- to 13-eV energy range, obtained by the trapped-electron method, is characterized by excitation of triplet states. The shape of the spectrum between 9.6 and 11.6 eV suggests the excitation of a repulsive or slightly stable state, which could be the $^5\Sigma_g^+$ state or some presently unknown state. In the 11.85- to 12.45-eV energy range the spectrum shows structure that can be closely related to the resonances seen in transmission experiments. (auth) (UK)

45021 THRESHOLD ELECTRON-IMPACT EXCITATION OF THE RARE GASES. Brion, C. E.; Olsen, L. A. R. (Univ. of British Columbia, Vancouver). J. Phys., B (London); 3: 1020-33(Jul 1970).

Threshold electron-impact spectra were obtained for the rare gases helium, neon, argon, krypton, and xenon using a velocity-selected electron beam. Zero-energy electrons ejected at excitation thresholds are scavenged by sulphur hexafluoride and the resulting SF_6^- ions are detected using a mass filter. Optically forbidden transitions are observed to make a large contribution to the total threshold excitation. The shape of the helium scavenging curve above the first ionization potential is discussed with regard to threshold laws for ionization by single electron impact. Excitation of outer s and p electrons in neon, argon,

krypton, and xenon is observed as well as other structure attributed to double electron excitation. (auth) (UK)

45022 MEASUREMENT OF DIFFERENTIAL CHARGE-TRANSFER CROSS SECTIONS AND PROBABILITIES BY PHOTON–PARTICLE COINCIDENCE TECHNIQUE. Jaecks, D. H.; Crandall, D. H.; McKnight, R. H. (Univ. of Nebraska, Lincoln). Phys. Rev. Lett.; 25: 491-4(24 Aug 1970).

The probabilities and differential cross sections for charge transfer to the 2p state of hydrogen in 4- to 20- keV proton–helium collisions were measured for specific impact parameters by detecting in delayed coincidence the scattered neutral hydrogen atom and the resulting 2p–1s Lyman-α photon. These 2p probabilities are compared with the total charge transfer and 2s state probabilities and with the coupled atomic state calculations of Sin Fai Lam. (auth)

45023 EXPERIMENTAL DETERMINATION OF THE ABSOLUTE DIFFERENTIAL CROSS SECTIONS FOR THE HELIUM $1^1S \rightarrow 2^1P$ TRANSITION PRODUCED BY ELECTRON IMPACT. Peresse, Joseph; Le Nadan, Andre; Pochat, Amedee (Brest Univ., France). Compt. Rend., Ser. B; 271: 31-3(6 Jul 1970). (In French).

The validity of the Born approximation for the $1^1S \rightarrow 2^1P$ transition in helium for an energy range between 40 and 150 eV and scattering angles between 0 and 20° is demonstrated. (auth) (France)

45024 PHENOMENON OF "SPREADING", OUTSIDE AN ELECTRON BEAM, OF THE FIRST AND SECOND POSITIVE BANDS OF NITROGEN. Outred, M. (Northern Polytechnic, London). J. Phys., B (London); 3: 928-31(Jul 1970).

When a well defined electron beam was used to excite nitrogen in a collision chamber, observations made of the light emitted from the regions of the chamber outside the geometry of the beam showed that the first and second positive band systems were present and also the second negative band system to a lesser extent. The process $N_2(A\,^3\Sigma_u^+) + N_2(A\,^3\Sigma_u^+) + N_2(X\,^1\Sigma_g^+) \rightarrow N_2(C\,^3\Pi_u) + N_2(X\,^1\Sigma_g^+) + N_2(X\,^1\Sigma_g^+)$ is proposed to account for the spreading of the second positive bands. This process also contributes to the spread of the first positive bands and is supplemented by the process suggested in 1934 by Thompson and Williams so that the larger spread is accounted for. (auth) (UK)

45025 EXCITATION OF Ca^+ BY ELECTRON IMPACT: POLARIZATION OF LINE RADIATION AND TRANSITIONS BETWEEN FINE-STRUCTURE LEVELS. Saraph, H. E. (University Coll., London). J. Phys., B (London); 3: 952-8(Jul 1970).

R matrices calculated by Burke and Moores (1968) for electron-impact excitation of the $3d\,^2D$ and $4p\,^2P$ levels in Ca^+ are used. Collision strengths for excitation of fine-structure levels are obtained at energies below and above the threshold for excitation of $4p\,^2P$. The polarization of radiation emitted from ^2P is related to the cross sections for excitation of the ^2P components. Calculated values for these cross sections and for the polarization of the $^2P - ^2S$ multiplet are given for a range of excitation energies. (auth) (UK)

45026 MEAN ENERGY EXPENDED PER ION PAIR BY ELECTRONS IN ATMOSPHERIC GASES. Khare, S. P. (Meerut Univ. Inst. of Advanced Studies, India). J. Phys., B (London); 3: 971-5(Jul 1970).

The expressions suggested by Khare for ionization cross sections per unit energy range were utilized to calculate the values of the mean energy expended in the production of an ion pair by a beam of fast electrons in molecular nitrogen and oxygen and atomic oxygen of uniform density. The values are practically constant for the energy of the incident electron greater than about 1 keV and are 15 to 20% higher than the experimental values. (auth) (UK)

45027 RESONANT EFFECTS ON THE LIGHT EMITTED BY A DIATOMIC MOLECULAR GAS EXCITED BY ELECTRONIC BOMBARDMENT: THEORY AND POSSIBILITIES. Nedelec, O.; Baltayan, P. (Faculte des Sciences, Grenoble, France). J. Phys., B (London); 3: L74-6(Jul 1970).

Density matrix and irreducible tensor operator formalism have been used to describe optical pumping or similar experiments by electronic excitation in an atomic gas. It is shown that this theory may be extended to diatomic molecules. Experimental possibilities are considered. (auth) (UK)

45028 OPTICAL RADIATION PRODUCED BY 1100-eV He^+, He^*, AND He^0 IN VARIOUS GASES. Hollstein, M.; Salop, A.; Peterson, J. R.; Lorents, D. C. (Stanford Research Inst., Menlo Park, Calif.). Phys. Lett.; 32A: 327-9(10 Aug 1970).

Optical spectra are observed associated with collisional excitation by He^+, He^*, He^0, Penning ionization by He^*, and charge transfer by He^+. Metastable He^* is collisionally excited to higher electron states, producing He I emissions, much more readily than is ground state He^0. (auth)

45029 ELECTRON IMPACT EXCITATION OF N_2. Brinkmann, R. T.; Trajmar, S. (California Inst. of Tech., Pasadena). Ann. Geophys.; 26: 201-7(1970).

An experimental and theoretical study was made of the excitation of molecular nitrogen under electron bombardment. Differential electron impact energy-loss spectra were obtained at scattering angles from 0 to 80° at incident energies of 15, 20, 30, 60, and 80 eV throughout the entire possible energy-loss range. Resolution was typically 0.01 eV. The resulting cross sections were put on an absolute scale by normalizing to known cross sections. Empirical and theoretical extrapolations were made for higher incident energies. A computer program was written that uses the Monte Carlo method to calculate the energy deposited in the various states as a function of incident energy and distance from the source. If branching ratios and quenching efficiencies are assumed, the resultant emission intensities are readily calculated. Illustrative results are presented for 100-eV incident electrons, this energy being intermediate between typical auroral and airglow cases of interest. (tr-auth) (France)

45030 ABSORPTION OSCILLOGRAM OF THE IONS CO_2^+ $(X^2\Pi_g)$ AND $N_2^+(X^2\Sigma_g^+)$ IN THEIR FUNDAMENTAL STATE PRODUCED BY PULSED RADIOLYSIS OF CO_2 AND N_2. Clerc, Michel; Lesigne, Bernard (CEN de Saclay, Gif-sur-Yvette, France). J. Chim. Phys.; 67: 701-3(Apr 1970). (In French).

Kinetics of the CO_2^+ and N_2^+ emissions and absorptions of the $CO_2^+(A^2\Pi_u - X^2\Pi_g)$ and $N_2^+(B^2\Sigma_u^+ - X^2\Sigma_g^+)$ transitions, were recorded with a time resolution of the order of 2×10^{-6} sec by pulsed radiolysis. The order of magnitude of the rate of recombination, extinction coefficient, and temperature of CO_2^+ are discussed. (tr-auth) (France)

45031 DEPOLARIZATION OF SLOW ELECTRONS CREATED BY THE IONIZATION OF A BEAM OF ALKALI ATOMS POLARIZED BY A BEAM OF FAST ELECTRONS. Coiffet, Philippe; Gilles, Jean-Paul (Paris Univ.). Compt. Rend., Ser. B; 270: 1613-16(22 Jun 1970). (In French).

The hypothesis of Ochkur concerning the form of the exchange amplitude occurring in the ionization of hydrogen by electrons is referred to; the theory is extended to the case of alkali metal atoms. The depolarization factor and the conditions under which this factor becomes negligible are discussed. By selection of very low-energy ejected electrons, it is demonstrated that ionization by electrons can be advantageously utilized to obtain polarized electrons from initially oriented atoms. (tr-auth) (France)

45032 UNIFIED MODEL FOR RESONANCES IN SCATTERING CROSS SECTIONS. Nazaroff, George V. (Michigan State Univ., East Lansing). Chem. Phys. Lett.; 6: 138-40(1 Aug 1970).

An infinite-order pertubation technique was used to obtain an expression for the T-matrix in the vicinity of a zero-order bound state of the target–projectile compound system. All zero-order bound states can contribute resonance structures to the scattering cross section. (auth)

45033 USE OF FADDEEV'S EQUATION TO CALCULATE THE SCATTERING LENGTH OF ELECTRONS ON HYDROGEN. Kotova, L. P.; Terent'ev, M. V. Dokl. Akad. Nauk SSSR; 190: 1312-14(21 Feb 1970). (In Russian).

Faddeev's equation has been applied successfully to determine the scattering of slow electrons on hydrogen atoms. In this connection, the convergence of separable decomposition of scattering amplitudes was examined beyond the bound and resonance states. The position of the bound states is ascertained by the zeros of the determinants of the systems of integral equations; the amplitudes are indicated by the numerator. If the convergence is satisfactory, the method may be applied to the study of the scattering of slow electrons on alkali metals. The method was used to calculate the length of singlet and triplet scattering on the ground state of the hydrogen atom, starting with the formula for the total elastic cross section. Differences were found between the triplet and singlet scattering. The physical reason for the difference is probably that the lower 1s approximation in the triplet case does not contain the amplitudes of the electron–electron scattering, the value of which greatly affects the ultimate results. (TTT)

45034 FORMATION OF HIGHLY EXCITED 30 TO 180 keV HELIUM ATOMS DURING CHARGE EXCHANGE AND THEIR IONIZATION IN A STRONG ELECTRIC FIELD. Il'in, R. N.; Oparin, V. A.; Serenkov, I. T.; Solov'ev, E. S.; Fedorenko, N. V.

(Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 59: 103-9(Jul 1970). (In Russian).

The formation of highly excited helium atoms (n = 9 to 17) during charge exchange of 30- to 180-keV He^+ ions on neon, sodium, or magnesium atoms was investigated. It was found that the population of highly excited states and the cross section for formation of highly excited atoms during charge exchange of helium ions and protons of identical velocities are very nearly equal. Some features of ionization of highly excited helium atoms by a strong electric field are discussed. (auth)

45035 CONFIGURATION-SPACE THREE-BODY SCATTERING THEORY. Gerjuoy, E. (Univ. of Pittsburgh). J. Phys., B (London); 3: L92-7(Aug 1970).

Results are quoted for the "physical" three-body transition operator yielding the volume-independent three-body reaction coefficient, in terms of which one computes the three-body elastic scattering rate when three initially free independently moving particles collide under the influence of short-range forces. (auth) (UK)

45036 AUGER EFFECT IN THE MULTIPLE IONIZATION OF MANGANESE AND CADMIUM BY ELECTRON IMPACT. Abouaf, Robert (Paris Univ., Orsay, France). J. Phys. (Paris); 31: 277-83(Apr 1970). (In French).

The Mn^{4+}, Mn^{5+}, Mn^{6+}, Cd^{5+}, and Cd^{6+} ions were shown to be formed by Auger processes following single primary ionization in 2p and 2s shells (Mn), the 3p shell (Cd^{6+}), or following double or triple primary ionization (Cd^{5+}, Cd^{6+}). At 1 keV the abundance of the Auger ions 5^+ and 6^+ was larger than that of ions produced by the direct process of simultaneous external electron ejection. The ionization curve and cross section variation of Mn^{2+} up to 2 keV showed an Auger process following ionization in the 3p shell. (tr-auth) (France)

45037 ELECTRON SCATTERING BY ATOMIC HYDROGEN USING A PSEUDO-STATE EXPANSION. II. EXCITATION OF 2s AND 2p STATES NEAR THRESHOLD. Geltman, S. (National Bureau of Standards, Boulder, Colo. Univ. of Colorado, Boulder); Burke, P. G. J. Phys., B (London); 3: 1062-72(Aug 1970).

The pseudostate modification of the close-coupling expansion is applied to the 2s and 2p excitation of atomic hydrogen by electron impact. Pseudostates are used which ensure the implicit inclusion of all important excited state polarizabilities. A detailed comparison is made with results obtained from other modifications of the close-coupling expansion, and the eigenphase minimum principle is used to determine the best result for each partial cross section. Comparison of the theory and experiment in the first electron volt above the n = 2 threshold shows very good agreement in the ratio Q(1s–2s)/Q(1s–2p), but a 20% discrepancy exists between the individual cross-section magnitudes when experiment is normalized to the Born approximation at higher energies. (auth) (UK)

45038 TOTAL IONIZATION CROSS SECTIONS OF He, N_2, H_2, AND O_2 DUE TO ELECTRON IMPACT. Khare, S. P. (Meerut Univ., India); Padalia, B. D. J. Phys., B (London); 3: 1073-82 (Aug 1970).

The total ionization cross sections of He, N_2, H_2, and O_2 due to electron impact were calculated by integrating the expressions given by Khare (1968 and 1969) for the ionization cross sections per unit energy range. The results are in satisfactory agreement with the experimental data. Comparison was also made with other theoretical values. (auth) (UK)

45039 LONG-RANGE EFFECTS IN 2s AND 2p EXCITATIONS OF HYDROGEN BY PROTON AND HELIUM-ION IMPACT. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). J. Phys., B (London); 3: 1083-9(Aug 1970).

The influence of the inclusion of the full interaction of an incoming ion with the various multipoles induced in the ground state of atomic hydrogen is investigated by considering the collisional excitation of the 2s and 2p states of hydrogen by protons and helium ions with impact velocities v in the range $0.4 \leq v \leq 5$ au. While the most significant change in the cross sections arises from the ion–dipole distortion, the ion–quadrupole term produces a relatively large effect that cannot be ignored in an accurate theoretical description of ion–atom collisions. The 2s cross section is increased by as much as 50% from the normal four-state treatment, while the excitation of the 2p magnetic substates is more severely affected. The polarization fraction of the emitted Lyman-α radiation is enhanced except at the lower incident energies, when rotational coupling between the magnetic substates becomes markedly evident. (auth) (UK)

45040 APPLICATION OF THE IMPACT PARAMETER METHOD TO ELECTRON–ATOM COLLISIONS. Vainshtein, L. A.; Vinogradov, A. V. (Lebedev Physical Inst., Moscow). J. Phys., B (London); 3: 1090-7(Aug 1970).

It has been shown previously that there is an exact relation between scattering amplitude in the wave treatment and the probability amplitude in the impact-parameter method. The analysis of the derivation of this relation makes it possible to modify the usual impact-parameter formulae for excitation cross sections of atoms by electron impact to include the difference between initial and final velocities. The modified formula provides close agreement with the quantum mechanical cross sections. The normalization of cross sections and the dipole approximation for electron–atom interactions both in impact-parameter and wave treatments are discussed and compared. Results are given for electron excitation of H 1s–2p, H 1s–2s, Na 3s–3p, He 3^3S–3^3P, He 2^3S–3^3P, and Ca $4s^2$–$4p^2$. (auth) (UK)

45041 MEASUREMENT OF THE CHARGE EXCHANGE CROSS SECTION IN He^+–H^- COLLISIONS. Gaily, T. D.; Harrison, M. F. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., B (London); 3: 1098-1104(Aug 1970).

The cross section for charge exchange in the reaction $He^+ + H^- \rightarrow He + H$ was measured over a range of relative velocities from 2.2 to 14.0×10^7 cm sec^{-1} (0.2 to 8.0 keV barycentric energy). The technique of modulated inclined ion beams developed for the observation of H^+–H^- collisions was used. The cross section falls from a value of 127×10^{-16} cm^2 at 2.2×10^7 cm sec^{-1} to 9.7×10^{-16} cm^2 at 14.0×10^7 cm sec^{-1} and exhibits prominent structure at intermediate velocities. The results are compared with those previously obtained for the H^+–H^- system. (auth) (UK)

45042 ELECTRON LOSS FROM FAST METASTABLE AND GROUND-STATE HELIUM ATOMS IN PASSAGE THROUGH GASEOUS TARGETS. Gilbody, H. B.; Dunn, K. F.; Browning, R.; Latimer, C. J. (Queen's Univ., Belfast). J. Phys., B (London); 3: 1105-12(Aug 1970).

A beam attenuation technique developed previously was used to obtain cross sections σ_{01} and σ_{0+1} for fast ground-state and metastable helium atoms in helium, neon, argon, krypton, and nitrogen at impact energies within the range 60 to 350 keV. Values were also obtained for targets of hydrogen and helium in the range 10 to 40 keV. Measured cross sections σ_{0+1} are shown to be in good agreement with values calculated recently by Bates et al. (1969) for targets of H_2, Ne, Ar, and Kr using a classical impulse approximation. The observed energy dependence of σ_{01} in the case of targets of hydrogen and helium is also found to be in good agreement with that predicted by the recent calculations of Bell et al. (1969) based on the first Born approximation. (auth) (UK)

45043 LABORATORY MEASUREMENTS OF EXCITATION COEFFICIENTS FOR FIVE TRANSITIONS IN NITROGEN V. Boland, B. C.; Jahoda, F. C.; Jones, T. J. L.; McWhirter, R. W. P. (Culham Lab., Abingdon, Eng.). J. Phys., B (London); 3: 1134-51(Aug 1970).

An experimental method for the determination of the electron-impact excitation coefficients is described. This requires the measurement of the absolute intensities of spectral lines emitted by a plasma in the extreme ultraviolet and the determination of the electron temperature of the plasma by a laser scattering technique. Results are presented for five transitions in four-times-ionized nitrogen. These are corrected for the effect of stepwise excitation and opacity and then compared with values calculated theoretically. The final results are in agreement with the theory to within the experimental uncertainty, which is ±20% for relative values and ±50% for absolute values. (auth) (UK)

45044 EXCITATION AND IONIZATION OF HYDROGEN BY HYDROGEN-ATOM IMPACT. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). J. Phys., B (London); 3: L97-100(Aug 1970).

Cross sections calculated from a semiquantal treatment are presented for the ionization of hydrogen and for the excitation of the second quantum level of hydrogen by collision with hydrogen atoms in the ground state. Comparison with the cross sections derived from Born's approximation shows excellent agreement. (auth) (UK)

45045 EXCITATION AND IONIZATION BY ELECTRON IMPACT. Bely, Oleg (Observatoire, Nice); van Regemorter, Henri. Annu. Rev. Astron. Astrophys.; 8: 329-68(1970).

The principles of the different theoretical methods for calculating

excitation and ionization cross sections are surveyed, and the reliability and accuracy of the various approximations are discussed. (228 references) (W.D.M.)

45046 ION–MOLECULE REACTIONS. McDaniel, E. W.; Cermak, V.; Dalgarno, A.; Ferguson, E. E.; Friedman, L. Wiley-Interscience Series in Atomic and Molecular Collisional Processes. New York; John Wiley and Sons, Inc. (1970). 386p. $19.95.

All known experimental methods for making quantitative studies of ion–molecule reactions are reviewed, and a critical analysis is made of the accuracy and reliability of these methods. The theoretical foundations of the subject and the various models adopted in computations of reaction rates are then discussed. A review is given of the measurements in the Earth's atmosphere from which information on ion–molecule reactions has been deduced, and this is followed by a discussion of ion–molecule chemistry. Experimental data on 230 ion–molecule reactions are displayed in tabular and graphical form. The data presented represent the results of a critical analysis of all available data and selection of best values. (A.G.W.)

45047 COHERENT AND INCOHERENT X-RAY SCATTERING BY BOUND ELECTRONS. II. THREE- AND FOUR-ELECTRON ATOMS. Brown, Robert T. (EG and G, Inc., Las Vegas, Nev.). Phys. Rev., A; 2: 614-20(Sep 1970).

Atomic form factors and incoherent-scattering functions for the lithium and beryllium isoelectronic sequences through Z = 8 have been calculated with correlated ground-state wave functions. The form factors differ from Hartree–Fock values by 1 to 2% and differ from Hartree–Slater values by as much as 10%. The incoherent-scattering functions are much more dependent on correlation, with the values for neutral beryllium differing from the Hartree–Fock values by as much as 30% at very small values of the momentum transfer. (auth)

45048 ELECTRON EXCHANGE IN H–H COLLISIONS: HEITLER–LONDON CURVES AS A FUNCTION OF INTERNUCLEAR DISTANCE AND VELOCITY. Ritchie, Burke (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A; 2: 759-62 (Sep 1970).

The Heitler–London curves for the interaction of two hydrogen atoms are calculated as a function of the internuclear distance and velocity. Electron-exchange terms are found to dominate the interaction energy at laboratory energy 1 keV, to be quite significant at 25 keV, and to be negligible at 400 keV. The exchange energy is attractive at 25 keV and below, but at 100 keV it is repulsive. Hence, in going from 25 to 100 keV, the singlet and triplet curves go from attractive and repulsive to repulsive and attractive, respectively, suggesting that an oscillatory behavior of the cross section versus energy is possible. These results have important implications for the calculation of atom–atom excitation cross sections in this energy range. (auth)

45049 SEMICLASSICAL CALCULATION OF ELASTIC H^+–He DIFFERENTIAL SCATTERING CROSS SECTIONS. Helbig, H. F.; Millis, D. B.; Todd, L. W. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Rev., A; 2: 771-4(Sep 1970).

Elastic differential cross sections for proton–helium scattering are calculated in the semiclassical approximation for two assumed interaction potentials. Both potentials are of the form $V(r; A, B, C) = (2/r)e^{-r/A}\ [1 + r/A + \frac{1}{2}r^2(1/A^2 - U/B)] - U[1 + r/B + (r/C)^2 + 2Ur^4/\alpha]^{-1}$, where U is the difference between the ground-state energies of He and Li^+ (4.373 11 Hartree) and α is the polarizability of He (1.3835 $Bohr^3$). The first potential $V_M \equiv V(r; 0.423, 0.483, 0.441)$ fits the He–H^+ ground-state energies calculated by Michels. The second, $V_W \equiv V(r; 0.442, 0.505, 0.451)$, is similar to V_M except that its minimum is decreased by 10% to agree with the value obtained by Wolniewicz. The cross sections for these two potentials are shown for protons incident at energies T of 7, 19, 58, and 116 eV in the laboratory frame and for scattering angles, at each energy, out to the rainbow angle θ_R. θ_R is given in center-of-mass coordinates by the expression $\theta_R T \cong 0.1$ rad Hartree. As the collision energy decreases, the cross sections develop oscillatory structure not present in the classical cross sections. This structure and the rainbow angle are sensitive to the choice of potential, which suggests that measurements of H^+–He cross sections may be used to test the suitability of, e.g., the Born–Oppenheimer potential for scattering phenomena. It is also suggested that many-body calculations of these cross sections would allow, by comparison with the present results, an evaluation of the potential scattering model. (auth)

45050 EIGENVALUE THEORY OF PARTICLE–BOUND-STATE SCATTERING. Payne, G. (Wisconsin State Univ., Oshkosh). Phys. Rev., A; 2: 775-81(Sep 1970).

In a previous publication, an n-body potential was used to transform the one-channel particle–bound-state scattering problem into a discrete-eigenvalue problem. A basic relationship was established in one particular case and used to study electron–hydrogen-atom scattering. A general relationship is now established, subject to some WKB estimates, providing the basis of a general theory of particle–bound-state scattering. The theory is extended to the n-channel case, both direct and exchange scattering being treated. The theory provides an explicit test of convergence of calculations based on it. An approximation designed to simplify computational labor is discussed. (auth)

45051 COMMENTS ON THE FADDEEV APPROACH TO THREE-PARTICLE COULOMB SYSTEMS. Shastry, C. S.; Rajagopal, A. K. (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 2: 781-6(Sep 1970).

Expressions correlating the transition operators to Faddeev's $T^{(i)}$'s are given for a three-body scattering problem. Using the results of Ball, Chen, and Wong, a revised partial-wave analysis for various transition processes in a three-particle Coulomb system is suggested. Some of the apparent contradictions between the off-shell two-particle partial-wave T matrix derived by Ball et al. and the full two-particle Coulomb T matrix derived by Nutt are resolved. In an Appendix, it is shown that $T^{(i)}$ is related to the transition operators. This establishes the equivalence between the limiting procedure of Ball et al. and the conventional procedure for obtaining the transition amplitudes. (auth)

45052 DIRECT MEASUREMENT OF THE DEPENDENCE ON ELECTRON DENSITY OF THE RECOMBINATION-RATE COEFFICIENT OF He_2^+ WITH ELECTRONS IN A HIGH-PRESSURE HELIUM PLASMA. Collins, C. B.; Hicks, H. S.; Wells, W. E. (Univ. of Texas, Dallas). Phys. Rev., A; 2: 797-806(Sep 1970).

A computer-linked spectroscopic system with a high-sensitivity-resolution product was used to measure the time-dependent net rate of production of neutral helium molecules resulting from the recombination of He_2^+ with electrons in a pulsed helium afterglow at a neutral pressure of 44.6 torr. The relative recombination-rate coefficient of He_2^+ as a function of afterglow time was obtained by dividing these data by the unscaled product of the electron and molecular ion density as determined from levels in Saha equilibrium with the free electrons. Simultaneous measurement of the electron density with a 35-Gc/sec microwave interferometer gave the unscaled rate coefficient as a continuous function of electron density over the range 10^{10} to 10^{12} cm^{-3} without the need of a priori assumptions about the functional form. Scale was established through integration of the rate equation for the loss of ions. Empirically, the rate coefficient can be represented as $\alpha = 2.8 \times 10^{-11}[e]^{0.185}$ cm^3/sec, where e is the electron density in cm^{-3}. (auth)

Atomic Theory

Refer also to abstracts 45398 and 45401.

45053 SIMPLE APPROXIMATION BEYOND HARTREE–FOCK. Borland, R. E.; Dennis, K. (National Physical Lab., Teddington, Eng.). J. Phys., B (London); 3: 887-91(Jul 1970).

The form of a real N-body fermion wave function when expanded in Slater determinants of natural orbitals is investigated using a computer. It is found that in the case when the number of natural orbitals is N + 2 there is a considerable reduction in the number of Slater determinants required. This offers the possibility of calculating atomic wave functions significantly more accurate than Hartree–Fock without an excessive amount of additional computing. In this approximation, pairing of orbitals occurs without invoking the concept of spin. (auth) (UK)

45054 NEGATIVE IONS AND SHAPE RESONANCES. Hunt, J.; Moiseiwitsch, B. L. (Queen's Univ., Belfast). J. Phys., B (London); 3: 892-903(Jul 1970).

A simple model potential having one adjustable radius parameter r_0 is employed to obtain electron affinities and the positions and widths of shape resonances by performing an extrapolation along an isoelectronic sequence of positive ions and the associated neutral atom. The values of the parameter r_0 are determined by requiring the potential to yield the experimentally observed energies of a given state of the members of the isoelectronic sequence. A quadratic extrapolation of r_0^{-1} then provides a model potential representing the field of the atomic core on the additional electron in the negative-ion system, stable or unstable, belonging to the isoelectronic sequence. This potential is then used to determine the energy of binding of the extra electron in the negative ion, if it exists, thus giving the electron affinity of the neutral atom concerned with an accuracy to within about 0.1 eV in most cases. Metastable states of certain negative ions are considered in the same manner. The model potential is also used to investigate the

elastic scattering of electrons by neutral atoms. When the potential field produced by the atomic core is insufficiently strong to bind the additional electron, p-wave shape resonances are found and the positions and widths of these have been determined. Atoms in the periodic table from hydrogen through chlorine have been investigated. (auth) (UK)

45055 ELECTRON CORRELATION IN RELATIVISTIC THEORY OF ATOMS. Labzovskii, L. N. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 59: 168-75(Jul 1970). (In Russian).

An expression for the correlation energy of a relativistic atom in the second order of perturbation theory with respect to electron interaction is obtained. The Gell-Mann and Low formula is employed for calculating the energy level shift. (auth)

45056 NEW POTENTIAL FUNCTION FOR ATOMIC AND SOLID-STATE CALCULATIONS. Liberman, David A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., B; 2: 244-9 (15 Jul 1970).

An expression for the potential energy of an isolated atom or a solid as a functional of the electron density is proposed. A one-electron potential function is derived from it by means of the variational principle. It has the correct asymptotic form at large radii in the case of atoms and ions. It also gives the correct total energy of the low-density electron gas. Calculations of binding energies of electrons in negative ions and of the bulk properties of some simple solids are given as examples of applications. (auth)

45057 NEW ANALYTICAL APPROXIMATION FOR THE THOMAS-FERMI MODEL IN ATOMIC PHYSICS. Ramnath, Rudrapatna V. (Electronic Associates, Inc., Princeton, N. J.). J. Math. Anal. Appl.; 31: 285-96(Aug 1970).

The Thomas-Fermi model is studied in the light of multiple scales. The governing equation for the effective nuclear charge in a heavy, neutral atom is converted into a set of partial differential equations by an extension of the radial distance into a space of higher dimension. This is done by using "scale functions" that are necessarily nonlinear. A new analytical approximation for the nuclear charge is obtained by solving the extended equations. It is seen that the result is useful in several respects; it provides enough arbitrary constants to absorb the boundary conditions, describes the correct asymptotic behavior both for small and large distances from the nucleus, and recovers a known exact solution under appropriate conditions. A uniform analytical description of the phenomenon is obtained and the approach is physically meaningful. (auth)

45058 INCORPORATION OF QUADRATIC CONVERGENCE INTO OPEN-SHELL SELF-CONSISTENT FIELD EQUATIONS. Hunt, William J.; Goddard III, William A.; Dunning, Thom. H. Jr. (California Inst. of Tech., Pasadena). Chem. Phys. Lett.; 6: 147-51(1 Aug 1970).

The quadratically convergent approach to solving the correct SCF equations for general open-shell systems (with orthogonal orbitals, i.e., multiconfiguration-SCF or Hartree-Fock) is derived and used to discuss other less complicated approaches. Representative calculations on He $2^1S[(1s)\ (2s)]$ and $H_2O\ 2^1A_1$ $[(1a_1)^2\ (2a_1)^2\ (1b_1)^2\ (1b_2)^2\ (3a_1)\ (4a_1)]$ are reported. (auth)

45059 RELATIVISTIC BOHR MODEL WITH FINITE-MASS NUCLEUS. Cushing, James T. (Univ. of Notre Dame, Ind.). Amer. J. Phys.; 38: 1145-50(Sep 1970).

An elementary but rigorous treatment is given of the Bohr model of hydrogen-like atoms in which first-order corrections are made for both the finite mass of the nucleus and for the relativistic motion of the electron. Particular attention is paid to the approximations necessary to obtain the energy levels first given by Sommerfeld. (auth)

45060 ELECTRON–ELECTRON INTERACTION IN ENERGY LEVEL DETERMINATION. Huebner, W. F. (Los Alamos Scientific Lab., N. Mex. Max-Planck Institut fuer Physik und Astrophysik, Munich). J. Quant. Spectrosc. Radiative Transfer; 10: 949-73(Sep 1970).

Electron–electron Coulomb interaction energies are expressed in terms of relativistic one-electron orbitals. The average electron–electron interaction energy, τ, is obtained and tabulated for Z = 1 and 30, for electron configurations in j–j coupling, from relativistic hydrogenic $F^{(o)}$ and nonrelativistic hydrogenic $G^{(k)}$ Slater integrals with $k \leq 6$. Coefficients $T(nljm, n'l'j'm')$ for the angular integrals in j–j coupling for f-electrons are calculated. A relationship to obtain these coefficients directly from the corresponding coefficients in L–S coupling is given. A perturbation method is described to obtain quickly approximate binding energies for the electrons in ions in their ground state, and for the electrons in ions and neutral atoms in excited states, from known binding energy data of neutral atoms corrected for the electron–electron interaction energy. (auth) (UK)

45061 HIGH-ORDER PERTURBATION THEORY AND PADE APPROXIMANTS FOR A ONE-ELECTRON ION IN A GENERALIZED CENTRAL-FIELD POTENTIAL. Iafrate, G. J. (Army Electronics Command, Fort Monmouth, N. J.); Mendelsohn, L. B. Phys. Rev., A; 2: 561-5(Sep 1970).

The solution to the nonrelativistic Schrödinger equation for a one-electron ion in a generalized central-field potential is investigated using high-order perturbation theory. It is shown that by utilizing a finite expansion of the perturbation-theory wave function in terms of associated Laguerre polynomials, perturbation-theory results can be obtained for any n,l state to arbitrarily high order. Results for the wave function and energy are explicitly given to third and fourth order, respectively. It is also shown that by reexpressing the high-order perturbation-theory energy expansion as a series of rational fractions (Padé approximants), accurate eigenvalues are obtained, even for large values of the expansion parameter. (auth)

45062 RANGE RELAXATION. III. VARIATIONALLY OPTIMAL INTEGRAL-TRANSFORM WAVE FUNCTIONS. Empedocles, Philip (Univ. of California, Berkeley). Phys. Rev., A; 2: 566-73(Sep 1970).

A general and formally exact class of integral-transform electronic wave functions may be defined in terms of a distortion operator. This operator, which depends on one or more running parameters, maps some zero-order approximate wave function onto any part of a Hilbert space. The set of all such distorted functions may then completely span the space. The most effective discrete set of n configurations for the approximation of the exact integral transform is considered from the standpoint of a numerical analysis. It is taken to be the set that permits the most accurate n-point evaluation of an integral expression for the expectation value of the energy. In practice, the diophantine integration scheme may be used to provide such a set of configurations. The value of the optimal transform weighting function for ground and excited states at each of the n points can be inferred back at the end via the solution to a conventional linear matrix eigenvalue equation. Preliminary applications are made to the calculation of the radial correlation limits for the helium, lithium, and beryllium atoms. (auth)

Cosmic Radiation

Refer also to abstracts 44317, 44321, 44322, 44887, 44890, 44940, 45086, 45480, and 45494.

45063 (AECL-3659) COSMIC RAY NM-64 NEUTRON MONITOR DATA. XV. Monthly Graphs, January–April 1970. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1970. 69p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada, using equipment maintained by AECL, are given in tabular form for the period from January to April 1970. Normalized graphs are given for the same period. Correction factors for the constant rates of drift of the barometers at Deep River and Inuvik were determined and are given. (auth)

45064 (INR-1162) PROPERTIES OF THE ELECTRON AND MUON COMPONENTS OF EXTENSIVE AIR SHOWERS FOR DIFFERENT MODELS OF HIGH ENERGY INTERACTIONS. Karakula, Szczepan (Institute of Nuclear Research, Warsaw (Poland)). 1970. 41p. Dep. CFSTI (U. S. Sales Only).

A theoretical analysis of the models of the development of extensive air showers based on the so-called CKP formula and a model based on the so-called isobar model was carried out. Various characteristics of extensive air showers and their fluctuations were calculated. (W.D.M.)

45065 DIURNAL ANISOTROPY OF COSMIC-RAY INTENSITY. Kane, R. P. (Physical Research Lab., Ahmedabad, India). J. Geophys. Res.; 75: 4350-3(1 Aug 1970).

Data from several neutron monitors were studied for the period 1953 to 1969. It is found that except for the quiet Sun year 1954 when amplitudes were small, the amplitudes have remained essentially constant around 0.3%, with a space direction of about 18 hours. The day-to-day and month-to-month scatter was large, yielding a monthly rms vector error of about 0.03 to 0.04%. This was almost 10 to 15% of the average amplitude and implied that long-term changes of less than 20 to 30% could not be detected with much reliability. Conclusions drawn from the present analysis are: the day-to-day variability of the diurnal variation of cosmic-ray intensity is very large; there are groups of days when amplitudes are almost zero and the corotation mechanism seems to

be inoperative; medium amplitudes (about 0.6% or less) are best explained on the basis of present theories; and for certain groups of days there is definite evidence of large increases from the 18-hour direction, and large decreases (about 1 and 2%) from roughly the garden hose (9 hour) direction. (J.C.W.)

45066 ALTITUDE DEPENDENCE OF THE BAROMETRIC COEFFICIENT OF COSMIC-RAY NEUTRON MONITORS. Singh, P. (Univ. of New Hampshire, Durham); Lockwood, J. A.; Razdan, H. J. Geophys. Res.; 75: 4354-6(1 Aug 1970).

The barometric coefficient β for a cosmic-ray neutron monitor as a function of latitude and altitude has been studied. Carmichael and Bercovitch (1969) observed the barometric coefficient (% per mm Hg) of the nucleonic component as a function of atmosphere depth (mm Hg) for stations at cutoff rigidities of 2 and 13 GV. Their observations, however, do not explain results at pressures greater than 600 mm Hg, because the secondary nucleonic energy continues to decrease all the way to sea level, but the barometric coefficient shows a steady decrease below 600 mm Hg. An attempt is made here to find β_v (the barometric coefficient for only vertically incident particles in a neutron monitor). The simple method uses the generalized Gross transformation and relates the vertically incident flux to the omnidirectional flux as a function of atmospheric depth. The only assumption made is that the absorption in any direction is a function of mass traversed in the air. The unambiguous increase in β_v now obtained confirms that the form of the β curve from Carmichael and Bercovitch observations is the result of two effects: the degradation of secondary nucleonic energy in the atmosphere and the contribution of obliquely incident cosmic rays. (J.C.W.)

45067 SOME RESULTS OF REGULAR MEASUREMENTS OF THE INTENSITY OF X-RAY PHOTONS IN THE ATMOSPHERE. Bazilevskaya, G. A.; Kvashnin, A. N.; Krasotkin, A. F.; Pankratov, A. K.; Charakhch'yan, A. N. (Lebedev Physics Inst., Moscow. Crimean Astrophysical Observatory, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 866-8(1969).

Translated from Geomagn. Aeron.; 9: 1071-3(1969).

The charged component of cosmic rays in the stratosphere has been measured regularly over Murmansk, Moscow, and Simferopol' since 1965. From these measurements, the intensity of the x-ray photons were obtained. The ratio of x-ray photon fluxes and charged-particle fluxes at various depths in the atmosphere were obtained for the three stations. RK-F balloon sondes were used and the instruments record all particles whose energy release in the crystal exceeds 20 Kev. (J.C.W.)

45068 LATITUDE AND ALTITUDE DEPENDENCE OF THE COSMIC-RAY ALBEDO NEUTRON FLUX. Jenkins, R. W.; Lockwood, J. A.; Ifedili, S. O.; Chupp, E. L. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 75: 4197-4204(1 Aug 1970).

Preliminary measurements of the cosmic ray albedo neutron flux above 400 km are reported for the period June 7 to 17, 1969. The measurements were made with a detector on board the Ogo 6 satellite that responds primarily to neutrons in the energy range 10^4 to 10^6 ev. The latitude variation of the counting rate was found to be 7.4/1 between 90° and 0°, similar to that predicted by Lingenfelter (1963). The neutron counting rate near the poles was found to decrease by 26 ± 5% between 450 and 950 km altitude, corresponding to a $R^{-4.2\pm0.3}$ dependence, where R is the distance from the center of the earth. This large altitude dependence excludes any angular distributions of neutron flux at the top of the atmosphere that are more peaked toward the vertical than cos θ (where θ is the angle from the vertical), but it is not in disagreement with an isotropic neutron flux. The total neutron leakage flux found by assuming isotropy was about 0.7 times that predicted by Lingenfelter (1963). The neutron leakage flux values obtained from the Ogo 6 experiment agree with those estimated from other experiments with a similar neutron energy response, if the same angular distribution is used. Estimates of the total neutron leakage flux, deduced from experiments responsive only to neutrons above 1 Mev by using the Lingenfelter (1963) and Newkirk (1963) energy spectra of leakage neutrons, show agreement with the lower energy results when the Newkirk spectrum is used but are up to twice as great as the lower energy results when the Lingenfelter spectrum is applied. (auth)

45069 CALCULATED COSMIC-RAY IONIZATION IN THE LOWER ATMOSPHERE. O'Brien, K. (Health and Safety Lab., New York). J. Geophys. Res.; 75: 4357-9(1 Aug 1970).

A high-energy transport code written for accelerator shielding purposes was applied to the calculation of cosmic-ray ionization at various atmospheric depths. In view of the biological interest, the calculation was performed for sea level and for an elevation of 2.5 cm over sea level (765 g/cm² depth in the atmosphere). The calculations were performed for a geomagnetic latitude of 51°. The atmosphere was represented by an infinite slab 1033 g/cm² thick. The ionization from protons, pions, and muons is determined along with the electromagnetic showers, total, hard, and electron flux contributions to cosmic radiation at sea level and 1033 g/cm² depth in the atmosphere and at an elevation of 2.5 km, and 765 g/cm² depth in the atmosphere. Results are tabulated. The hard, total, and electron flux components are compared at the two atmospheric depths for experimental and theoretical results. (J.C. W.)

45070 ACCELERATION OF COSMIC ELECTRONS AND POSSIBLE MECHANISM OF FORMATION OF THE SPECTRUM OF METAGALACTIC X RADIATION. Gnedin, Yu. N.; Dolginov, A. Z. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 11: 366-9(5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 534-7 (5 Jun 1970).

The spectrum of the electrons responsible for the background x radiation corresponds to the spectrum of the electrons of the Milky Way, which has been determined both on the basis of radioemission data and by direct measurements. However, the mechanism of formation of this spectrum has not been considered. It is shown that precisely such a spectrum can arise in the case of acceleration and scattering of electrons by inhomogeneities of the magnetic field of a moving plasma. (W.D.M.)

Direct Energy Conversion

Refer also to abstracts 44776 and 44790.

45071 PERFORMANCES OF AN MHD GENERATOR CHANNEL. Ogiwara, Hiroyasu (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Jap. J. Appl. Phys.; 9: 825-30(Jul 1970).

Generalized representations of the performances of an MHD generator channel are developed, using the generalized Ohm's law, in which the factors affecting the generating characteristics are treated as the two global coefficients which limit the output voltage and current. Those coefficients are F value and a new loading factor K' defined in this report. The degradation of the generating characteristics can be well explained with those coefficients. The examples of the application of the representations are also discussed, in which the methods for improvement of the generating characteristics are discussed and, as a result, reduction in the F value is theoretically derived for the channel with the pin electrodes shorting the boundary-layer resistances. A nearly ideal F value of the MHD channel was obtained in the MHD generation experiment with the pin electrodes. (auth)

45072 ELECTRICAL CHARACTERISTICS OF MHD GENERATOR WITH RESISTIVE SEGMENTED ELECTRODES IN THERMAL EQUILIBRIUM. Yoshikawa, Kiyoshi; Michiyoshi, Itaru (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 394-400(Aug 1970).

The feasibility of easing the concentration of the current at the electrode edges through the adoption of resistive segmented electrodes, and leading out the current from the electrodes at the edges opposite the points where the current usually concentrates is studied. Numerical analyses were performed both by the difference method and by the iteration method, assuming constant gas-dynamical parameters and uniform channel cross section. The results reveal that when the resistivity of the electrodes is moderate, the current distribution becomes fairly symmetric in reference to the electrode center, and the current concentration on the electrode edge is thus greatly reduced. When the Hall parameter is large, the internal resistance in case of resistive electrodes becomes nearly equal to that of nonresistive electrodes. For small Hall parameters, however, the internal resistance is appreciably greater in resistive than in nonresistive electrodes. (auth)

45073 STUDY OF INFLUENCE OF NONUNIFORMITY OF FLOW PARAMETERS AND IMPERFECT WALL INSULATION ON MHD-GENERATOR PERFORMANCE IN PRESENCE OF HALL EFFECT. Bityurin, V. A.; Buznikov, A. E.; Vanin, V. E.; Kirillov, V. V.; Kovbasyuk, V. L.; Lyubimov, G. A.; Medin, S. A.; Sokolov, Yu. N. (Inst. of High Temperatures, Moscow). Energy Convers.; 10: 143-7(Jul 1970).

Real effects in an MHD-generator duct are considered, an experimental study is described, and factors deteriorating performance of the generator are discussed. An analytical study of these factors is presented, together with a theoretical model of the flow with the patterns of longitudinal and transverse current loops. A comparison of the measured and calculated characteristics of the generator is made. (auth) (UK)

45074 ELECTRICAL CHARACTERISTICS OF AN MHD CHANNEL USING ARC CATHODES IN A POTASSIUM-SEEDED ARGON PLASMA. Shirakata, Hirofumi; Yano, Syukuro (Japan Atomic Energy Research Inst., Tokai). Jap. J. Appl. Phys.; 9: 964-70 (Aug 1970).

The effects of the arc cathode on electrical characteristics of the MHD channel were investigated. Two experiments using a potassium-seeded argon gas were made: one was the applied field experiment at 1790°K and 1 atm, and the other was the preliminary generator experiment at 1850°K and 1 atm. In the applied field experiment, it was found that the cathode sheath resistance was decreased by two figures when the arc cathode was operated. In the generator experiment, the increment of the true generator current induced by the MHD effect became evident from the results of analysis by the use of an equivalent circuit. (auth)

45075 MODEL OF THE FARADAY-TYPE MHD GENERATOR WITH HOT ELECTRONS. Golubev, V. S.; Malikov, M. M.; Nedospassov, A. V. (Kurchatov Atomic Energy Inst., Moscow). Energy Convers.; 10: 123-4(Jul 1970).

The preliminary results from an experimental Faraday-type MHD-generator study are reported. Image converter photographs of the plasma in the generator channel are given and clearly show streamers oriented along the direction of the Faraday current but no highly conducting electrode layers are in evidence. Power measurements are also reported and the significance of the results is discussed. (auth) (UK)

45076 SURVEY OF LIQUID-METAL MAGNETOHYDRODYNAMIC ENERGY CONVERSION CYCLES. Morse, Frederick H. (Univ. of Maryland, College Park). Energy Convers.; 10: 155-76(Jul 1970).

Interest in liquid metal magnetohydrodynamic (LM–MHD) power generation has developed because of its high power density, its ability to operate both ac and dc generators, and the possibility of operation at moderate temperatures. Recent advances in LM–MHD have made the evaluation of such systems for spacecraft power supply feasible. All of the reported LM–MHD power generation cycles are described and their efficiencies compared. A brief summary of the evolution and status of the LM–MHD power generation systems and a listing of facilities engaged in LM–MHD work is also included. (auth) (UK)

45077 THERMIONIC CONVERTER WITH HALL EFFECT COLLECTION MEANS. Davis, Edwin D. U. S. Patent 3,519,854. 7 Jul 1970. Filed 20 Feb 1967.

A plurality of electrostatic electrodes shape the electron beam prior to collection, and either permanent magnet or electromagnetic means may be used to provide the transverse magnetic field for the Hall plates. (auth)

45078 MEASUREMENT OF THE EFFECTIVE DISSOCIATION POTENTIAL OF SEED COMPOUNDS IN MHD EXPERIMENTS. Fu, T.; George, D. W.; Messerle, H. K.; Sakuntala, M. (Univ. of Sydney). J. Appl. Phys.; 41: 3268-73(Jul 1970).

A method is developed for the determination of the effective dissociation potential (V_d) of an alkali compound used as a seed in the low-temperature and high-pressure working fluid of a magnetohydrodynamic (MHD) generator. For a simple compound like potassium chloride (KCl) V_d can be derived directly by measuring the ion density in the plasma from the current–voltage characteristics observed in MHD generator. For complex seed compounds like potassium sulphate (K_2SO_4), the method leads to an effective V_d as referred to an assumed dissociation reaction. Additional experimental information as to the specific radical involved would be required to establish the true dissociation energy. In the experiments presented here, the working gas is argon at atmospheric pressure and the temperature ranges from 2000° to 3000°K. In the temperature range used and for KCl undergoing the reaction $KCl \rightleftharpoons K + Cl$, the actual dissociation potential V_d is found to be 3.6 ± 0.4 eV. For K_2SO_4 the assumed dissociation reaction, $K_2SO_4 \rightleftharpoons 2K + S + 4O$ leads to the effective $V_d = 10.7 \pm 3.1$ eV. (auth)

Fluid Physics

Refer also to abstracts 44184 and 45073.

45079 MAXWELL EQUATIONS APPLIED TO POLARIZABLE MEDIA AND TO BINGHAM MAGNETODYNAMIC FLUIDS. Duvaut, Georges; Lions, Jacques-Louis (Paris Univ.). Compt. Rend., Ser. A; 270: 1600-3(15 Jun 1970). (In French).

It was shown in a previous paper (Compt. Rend., Ser. A; 270: 58-61(1970)) how the dynamics of Bingham fluids could be investigated using variational inequalities. The application of similar techniques to the study of electromagnetism in polarizable media and the magnetodynamics of Bingham fluids are discussed. (France)

45080 VARIATIONAL PRINCIPLE FOR MAGNETOHYDRODYNAMIC CHANNEL FLOW. Wenger, Norman C. (Lewis Research Center, Cleveland). J. Fluid Mech.; 43: 211-24(17 Aug 1970).

A variational formulation is presented for a class of magnetohydrodynamic (MHD) channel flow problems. This formulation yields solutions for the fluid velocity and the induced electric potential in a channel with a uniform transverse static magnetic field. The channel cross section is constant but arbitrary, and the channel walls can be either insulators or conductors with finite electrical conductivity. Electric currents are permitted to enter and leave the channel walls so that the solutions are suitable for MHD generator and pump applications. An example of a square channel with conducting walls is solved as an illustration. (auth) (UK)

45081 MAGNETOHYDRODYNAMIC CHANNEL FLOW OF SUSPENSION. Yang, Wen-jei; Ou, Jenn-wuu (Univ. of Michigan, Ann Arbor). Jap. J. Appl. Phys.; 9: 992-6(Aug 1970).

An analytical method is developed to determine the flow and heat transfer characteristics of suspensions in a parallel-plate channel under the influence of electric and magnetic fields. The flow is fully developed to Hartmann profile and the rheological behavior of the suspensions obeys the power-law model. Two cases of wall thermal condition are considered: the prescribed wall heat flux and the prescribed wall temperature. Numerical results show considerable deviations in the Hartmann profile, viscous and Joule heating, and heat transfer rate when the rheological characteristics of the suspension deviates from a Newtonian one. (auth)

45082 MAGNETOHYDRODYNAMICAL SUPERSONIC FLOW OF A SLIGHTLY CONDUCTING FLUID PAST A SLENDER BODY OF REVOLUTION PLACED IN A CIRCULAR WIND TUNNEL. Suwa, Shigeaki (Defense Academy, Yokosuka, Japan). Jap. J. Appl. Phys.; 9: 857-65(Aug 1970).

The wind tunnel interference problem in magnetohydrodynamics, in which an inviscid compressible fluid with small electrical conductivity flows steadily past a slender axisymmetric pointed body of revolution in a cylindrical perfectly insulated wind tunnel, in the presence of an applied slightly inclined magnetic field, is considered. The interference is found to induce electric field even if $R_m \approx 0$. The lift of the body changes its sign according to the direction of the angle between the applied magnetic field and the direction of the uniform flow at infinity. (auth)

45083 UNSTEADY HYDROMAGNETIC FLOW DUE TO A ROTATING DISK. Pop, Ioan (Univ. of Cluj). Bull. Cl. Sci., Acad. Roy. Belg.; 55: 1010-16(1969).

The flow of a viscous electrically conducting incompressible fluid due to an infinite rotating disk is analyzed, when a uniform magnetic field acts perpendicularly to the disk. The solution is obtained by expanding the velocity components in powers of a hydromagnetic parameter. (auth)

45084 NOTE ON HYDROMAGNETIC FLOW ABOUT A MOVING DISC. Baral, Manindra Chandra (Tripura Engineering Coll., Agartala, India). Beitr. Geophys.; 78: 341-7(1969).

The motion of a conducting liquid about a disc executing a transient torsional motion is investigated. Laplace transforms are used to solve the problem. (auth)

45085 THEORETICAL STUDY IN THE REGION OF APPLICABILITY OF THE DARCY LAW CONCERNING THE FLOW OF A VISCOUS AND ELECTRICALLY CONDUCTING FLUID ACROSS A POROUS NONCONDUCTING MEDIUM IN THE PRESENCE OF A MAGNETIC FIELD. Daoud, Mohamed Ben; Vives, Charles (Alger Univ., Algeria). Compt. Rend., Ser. A; 270: 1764-67 (29 Jun 1970). (In French).

The cases of a medium pierced by randomly orientated cylindrical channels, and of an assemblage of identical spheres, in the presence of magnetic field were successively studied; the field was axial or transverse to the direction of the average flow. In the second case, agreement between theory and experiment was good. (France)

Geophysics (Upper Atmosphere)

Refer also to abstracts 44114, 44115, 44894, 45029, 45068, 45069, and 45531.

45086 (HASL-234) MEASUREMENTS OF COSMIC-RAY IONIZATION IN THE ATMOSPHERE, 1968–70. Raft, P. D.;

Lowder, W. M.; Beck, H. L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Aug 1970. 28p. Dep. CFSTI.

Balloon measurements of cosmic-ray ionization and charged-particle dose rate in the atmosphere were commenced in 1968 as an extension of the program of environmental radiation dosimetry at ground level. Argon-filled ionization chambers equipped with MOSFET electrometers and with various gas pressures and steel wall thicknesses were utilized. A study of their response in the laboratory and at altitude indicates that the free-air ionization profile in the atmosphere can be determined to an accuracy of ±5% (s.d.). Data from five flights between May 1969 and June 1970 at 53° and 42°N geomagnetic latitude provide ionization profiles consistent with HASL ground level results, but 16% lower than comparable data from the California Institute of Technology. The measured ionization (dose rate) at 53°N for 10,000, 35,000, and 65,000 ft are, respectively, 6.3 I(9.5 μRad/hr), 114 I(170 μRad/hr), and 290 I(436 μRad/hr). These results are approximately minimum values for the 11-year solar cycle. (auth)

45087 (JPRS-51308) UPPER ATMOSPHERE AND SPACE RESEARCH IN THE USSR IN 1969. Efremov, Yu. I. (ed.). Translation of Issledovaniya Verkhney Atmosfery i Kosmicheskogo Prostranstva v SSSR v 1969 Godu, Russian, Nauka Publishing House, 1970. 198p. CFSTI.

Space research in the USSR in 1969 included an investigation of the Moon, the planets, and the Sun; an investigation of the processes and phenomena taking place in space; a study of the Earth's atmosphere; medical and biological investigations; improvement of the methods of utilizing outer space; and the use of satellites for communication and weather services. In 1969 group flights were achieved with two ships, Soyuz-4 and Soyuz-5, and with three ships, Soyuz-6, Soyuz-7, and Soyuz-8. Outstandingly successful were the flights of the automatic interplanetary stations Venera-5 and Venera-6. (tr-auth)

45088 MAGNETIC FIELD MAPPING OF THE INNER MAGNETOSPHERE. Cain, Joseph C.; Sweeney, Ronald E. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 4360-2(1 Aug 1970).

Data from Ogo 2, 4, and 6 spacecraft operating at 400 to 1500 km in polar orbits since 1965 have been used to represent sets of coefficients for magnetic field mapping of the inner magnetosphere. A new model, labeled Pogo(8/69), is derived by fitting all the data taken during quiet intervals from October 1965 through May 1968 with a series of internal spherical harmonics and their first derivatives in time. The model is specifically useful at altitudes below 1000 km. (J.C.W.)

45089 ACCIDENTAL ROCKET OBSERVATION OF $O_2(^1\Delta_g)$ IN AN AURORA. Schiff, H. I. (York Univ., Toronto); Haslett, J. C.; Megill, L. R. J. Geophys. Res.; 75: 4363-5(1 Aug 1970).

Intense emissions of 1.27-μ radiation from $O_2(^1\Delta_g)$ have been observed in aurorae. The ratio of the 1.27-μ intensity to the intensity of the visible emission is too large to be explained by excitation of the atomic oxygen by incoming high-energy electrons. A rocket was launched from the Churchill Research Range at 1812 LT on December 3, 1969, to gather further data on this anomaly. Results show that at least twice as much energy is radiated as 1.27-μ photons than can be deposited by incoming particles capable of exciting the observed 5577-Å emission. It is confirmed that some energy source other than high-energy particles must be invoked to explain the atomic oxygen excitation in these aurorae. (J.C.W.)

45090 IONOSPHERIC Si^+ AND SiO^+. Ferguson, E. E.; Fehsenfeld, F. C.; Whitehead, J. D. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 4366-8(1 Aug 1970).

Narcisi's observation of Si^+ and SiO^+ ions in a thin layer at 110 km during a Leonid meteor shower implies an interconversion of these ions. It is proposed that the process involved is an "equilibrium" $Si^+ + O_2 \rightleftharpoons SiO^+ + O$. This process requires an elevated O_2 vibrational temperature, from 500° to 1500°K, depending on uncertainties in the SiO^+ bond strength. Since SiO^+ presumably has a large electron dissociative recombination, the observed $Si^+ + SiO^+$ abundance implies a relatively large atmospheric silicon abundance as compared with other meteor species. (auth)

45091 EQUATORIAL ELECTROJET: SEASONAL VARIATION OF THE REVERSAL TIMES. Balsley, Ben B. (ESSA Aeronomy Lab., Boulder, Colo.). J. Geophys. Res.; 75: 4369-71 (1 Aug 1970).

Data are presented that indicate the seasonal variation of the time of the morning and evening current reversals in the equatorial electrojet. The current reversal implies a reversal of the east–west electric field that drives the current system, so that the data may be used to infer the reversal times of the horizontal electric field system in equatorial latitudes. In this analysis, direct measurements of the reversal times were obtained from the spectral analysis of vhf radar echoes returned from irregularities in the electrojet at oblique angles and reversal times inferred from the time of minimum signal strength on a transequatorial vhf-scatter path that was operated during the IGY near the 75°W meridian. Graphs are presented for the morning and evening reversal of equatorial electric fields vs season. (J.C.W.)

45092 TRAPPED ENERGETIC NUCLEI $Z \geq 3$ IN THE EARTH'S OUTER RADIATION ZONE. Krimigis, S. M. (Johns Hopkins Univ., Silver Spring, Md.); Verzariu, P.; Van Allen, J. A.; Armstrong, T. P.; Fritz, T. A.; Randall, B. A. J. Geophys. Res.; 75: 4210-15(1 Aug 1970).

The observations reported here were made with the University of Iowa Injun 5 satellite, which was launched on August 8, 1968, into an orbit of 81° inclination with initial apogee and perigee altitudes of 2525 and 644 km, respectively. The satellite carried an 8.5-μ thick, totally depleted surface-barrier detector, with four discrimination levels, three of which are sensitive to α particles, whereas the fourth is sensitive only to nuclei $Z \geq 3$. The following represents a summary of preliminary results, with respect to nuclei $Z \geq 3$. (a) The steady-state intensity ratio of trapped intensity of (medium mass) nuclei $Z \geq 3$ to that of α particles ϵ_m, $\epsilon_\alpha \gtrsim 0.32$-Mev/nucleon is, to an uncertainty of a factor of two, $j_m/j_\alpha \sim 10^{-3}$, in the L range 2 to 4 R_E and B range 0.15 to 0.25 gauss; the intensity j_m is (0.05 ± 0.03) $(cm^2 sec\ sr)^{-1}$. (b) The intensity of nuclei $Z \geq 3$ increased by a factor of $\sim 10^2$ over the steady-state value, following the magnetic storms of November 1, 1968, and February 2, 1969; the j_m/j_α ratio on November 8, 1968, had the enhanced value $(8 \pm 3) \times 10^{-3}$. The results are discussed in the context of the origin of trapped nuclei. It is concluded that the present evidence is inadequate to distinguish between the solar wind and the earth's exospheric gas as basic ion sources. (auth)

45093 RELATIONSHIP OF GEOMAGNETIC FLUCTUATIONS TO OTHER MAGNETOSPHERIC PHENOMENA. Cole, K. D. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 4216-23(1 Aug 1970).

An analysis is presented of geomagnetic fluctuations as observed at the surface of the earth during the onsets of the main phases of some magnetic storms. The global morphology of these fluctuations with the position of the ring current and plasmapause formed in the magnetosphere as inferred by satellite magnetometer and particle measurements are compared. It is found that the ring current is formed on the innermost disturbed L shells of the magnetosphere. The plasmapause in the cold magnetospheric plasma is at or near the outermost L shell of the relatively undisturbed magnetosphere. When observed, the SAR arc appears on the innermost disturbed L shells of the magnetosphere. (auth)

45094 HIGH-ALTITUDE MEASUREMENT OF THE LYMAN ALPHA NIGHTGLOW AT SOLAR MINIMUM. Meier, R. R.; Weiss, D. M.; Mange, P. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 75: 4224-9(1 Aug 1970).

Observations of the geocoronal Lyman α emission rate were obtained as a function of altitude at local midnight near the minimum of solar activity. Solution of the appropriate radiative transfer equations for several hydrogen models, combined with observations of both the solar flux and the extraterrestrial Lyman α background, suggests a reference hydrogen density at 100 km in the range from 6.3×10^6 to 2×10^7 cm^{-3}, with a best estimate of 1.6×10^7 cm^{-3}. This implies an increase in the hydrogen production rate of nearly a factor of 2 from January 1964 to fall 1967. (auth)

45095 VLF RADIO OBSERVATIONS OF MAGNETIC IMPULSES IN THE PLASMASPHERE. McNeill, F. A. (Physics and Engineering Lab., Lower Hutt, N. Z.). J. Geophys. Res.; 75: 4230-4 (1 Aug 1970).

Observations of vlf radio waves traveling via the whistler mode have indicated a common origin for the abrupt frequency shifts of these signals and the simultaneous sudden impulses and sudden commencements of magnetic storms, as registered by ground-based magnetometers. A study of this relationship suggests that, during the disturbances, observations of whistler mode signals from vlf transmitters can yield useful information on the behavior of the plasmasphere. (auth)

45096 VLF DUCT ASSOCIATED WITH THE LOWER-HYBRID-RESONANCE FREQUENCY IN A MULTI-ION UPPER IONOSPHERE. Gross, S. H. (Polytechnic Inst. of Brooklyn Graduate Center, Farmingdale, N. Y.). J. Geophys. Res.; 75: 4235-47(1 Aug 1970).

As a result of the presence of two or more ions with different

height profiles in the upper F region of the ionosphere, propagation ducts that are associated with the lower-hybrid-resonance frequency may form. Such ducts are generally oriented along a horizontal direction. These ducts were originally suggested as a mechanism for the explanation of certain vlf hiss bands observed by a number of satellites with electric antennas. They were questioned, however, as a result of detections of vlf noise components at frequencies well above their trapping bands. The conditions in a diffusive equilibrium region under which such ducts may form are investigated. It is found that the ducts are essentially narrow-band guides with maximum possible bandwidths of the order of 2.5 to 3.0 kHz; the bandwidths vary with altitude. Duct quality is found to depend on the parameters at the ion density crossover level and at the F-region peak. Duct formation is favored by low electron density conditions, thus implying that their existence at high midlatitudes in or near the ionospheric trough is favored. Preliminary examination of data from the vlf receiver connected to the long electric antenna on Alouette 1 revealed a number of hiss events for the year 1963 with bandwidths that fit the duct properties. (auth)

45097 WHISTLER OBSERVATIONS OF THE INTERCHANGE OF IONIZATION BETWEEN THE IONOSPHERE AND THE PROTONSPHERE. Park, C. G. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 4249-60 (1 Aug 1970).

Whistlers recorded at Eights, Antarctica, in June 1965 were used to measure the electron content in magnetospheric tubes of force in the range $3.5 < L < 5$. Under quiet geomagnetic conditions, the observed rate of increase in daytime tube content gives an upward flux of $\sim 3 \times 10^8$ electrons/cm^2 sec across the 1000-km level, which is larger than the downward flux necessary to maintain the nocturnal ionosphere. The observed upward flux is primarily due to diffusion of protons through the diffusive barrier, rather than to an increase in the height of the barrier. The downward flux at night under quiet conditions is $\sim 1.5 \times 10^8$ electrons/cm^2 sec, an amount that is considered sufficient to maintain the nocturnal ionosphere. The protonosphere is depleted in less than a day during a magnetic storm or polar substorm activities, and subsequent recovery of tube content takes place at a rate of $3-5 \times 10^{12}$ electrons/cm^2 per day. At this rate, an empty tube requires about 5 days to reach the monthly median value, and even after 8 days of quiet conditions it continues to fill. The average spacing of geomagnetic disturbances is such that it is expected that the protonosphere almost never reaches the saturation level it would attain if it were in equilibrium with the ionosphere. (auth)

45098 COMPARISON OF CALCULATED AND OBSERVED FEATURES OF A STABLE MIDLATITUDE RED ARC. Roble, R. G. (National Center for Atmospheric Research, Boulder, Colo.); Hays, P. B.; Nagy, A. F. J. Geophys. Res.; 75: 4261-5 (1 Aug 1970).

The Alouette 2 satellite passed over a stable midlatitude red arc on September 28–29, 1967. The electron temperature was measured at the satellite, and a topside sounder determined the electron density structure to the F2 peak. The data are used to calculate the intensity and extent of the red arc; heat flow into the ionosphere via thermal conduction is considered as the only energy source. The calculated 6300-A emission, photometric structure, height of the peak emission, and position of the arc are in general agreement with the observational data of the Fritz Peak airglow observatory. (auth)

45099 ENERGY SPECTRA OF PRECIPITATING ELECTRONS FROM OBSERVATIONS OF OPTICAL AURORA, BREMSSTRAHLUNG X RAYS, AND AURORAL ABSORPTION. Christensen, Andrew B. (Univ. of Denver); Karas, Richard. J. Geophys. Res.; 75: 4266-78 (1 Aug 1970).

Simultaneous balloon observations of auroral N_2^+ (λ3914) emission and bremsstrahlung x rays produced by the precipitation of energetic electrons in the auroral zone suggest that two distinct groups of electrons are responsible for the observed effects. One group is responsible for the major portion of the total precipitated energy during visible aurora, and at times this group not only provides the dominant flux of x rays below about 40 keV but also accounts for most of the cosmic noise absorption. A remarkable feature of this group is the extent to which its average energy may vary, i.e., from several keV to greater than 25 keV during the post-midnight hours. A second group of particles is responsible for the x-ray flux above 50 keV; however, the total power deposited in the atmosphere by this group is seldom greater than a few tenths erg cm^{-2} sec^{-1}. The spectrum of these electrons can be represented by a simple exponential function with an e-folding energy usually between 40 and 65 keV. A recognition of these features of the spectrum leads to a better understanding of the relationship between optical, x-ray, and auroral absorption events. (auth)

45100 SEQUENCE OF DIFFUSE PLASMA RESONANCES OBSERVED ON ALOUETTE 2 IONOGRAMS. Oya, Hiroshi (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 4279-85 (1 Aug 1970).

An investigation of more than 1400 Alouette 2 ionograms indicates that a sequence of diffuse plasma resonances exists and that these resonances are grouped according to the following plasma conditions: (1) f_{D1} is observed between 1.3 and $2f_H$ when $2.2 < f_N/f_H < 3.6$, (2) f_{D2} is observed between 2.4 and $3f_H$ when $3.8 < f_N/f_H < 4.8$, (3) f_{D3} is observed between 3.5 and $4f_H$ when $4.5 < f_N/f_H < 5.8$, (4) f_{D4} is observed between 4.5 and $5f_H$ when $5.5 < f_N/f_H < 6.8$, where f_{Dn} is the frequency of the diffuse plasma resonance, f_H is the electron cyclotron frequency, and f_N is the plasma frequency. When these conditions are satisfied, the corresponding f_{Dn} resonances are observed nearly 100% of the time. Diffuse resonances could not be identified when $f_N < 1.8f_H$ or when $f_N > 6.8f_H$; the upper limit may be due to insufficient frequency resolution. The diffuse resonance f_D, reported earlier by others as occurring at or near $1.5f_H$, corresponds to f_{D1} of this sequence. A nearly linear increase of f_{Dn} with increasing f_N/f_H is observed for $n = 1$ and $n = 2$ with dip near $f_N/f_H = 3$ for $n = 1$; the correlation for n higher than 3 is not as apparent. The present observations cannot be explained in terms of pure Bernstein-mode electrostatic waves. (auth)

45101 TOPSIDE PLASMA FREQUENCY RESONANCE BELOW THE CYCLOTRON FREQUENCY. McAfee, J. R. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 4287-90 (1 Aug 1970).

The behavior of the resonance at the plasma frequency, when that frequency is less than the electron cyclotron frequency, is quite different from the previous investigations where the plasma frequency is larger. Ray paths are again found that will return energy to a moving topside sounder over a range of frequencies and corresponding delay times. Only one type of ray path is found, however, and its reflection takes place in the less dense region above. Furthermore, there is a maximum delay time above which no paths are possible, so that the observation of the ringing should be limited to a short range of delay times. (auth)

45102 OGO 4 SPECTROMETER MEASUREMENTS OF THE TROPICAL ULTRAVIOLET AIRGLOW. Barth, C. A.; Schaffner, S. (Univ. of Colorado, Boulder). J. Geophys. Res.; 75: 4299-4306 (1 Aug 1970).

The Ogo 4 ultraviolet spectrometer measured the ultraviolet nightglow at tropical latitudes. The spectrum consists of the 1304- and 1356-A lines of atomic oxygen. The Lyman–Birge–Hopfield bands of molecular nitrogen and the ultraviolet lines of atomic nitrogen do not appear. The tropical ultraviolet airglow occurs in two bands north and south of the geomagnetic equator under satellite observation conditions that are best correlated with a local time of 2100 to 2130. When the intensity of this airglow is maximum, the ratio of the intensity of the 1304-A to the 1356-A line is 1.8. The most likely source of excitation of the tropical ultraviolet airglow appears to be an ionospheric recombination mechanism. (auth)

45103 PRODUCTION AND DIFFUSION OF NITRIC OXIDE. Strobel, D. F.; Hunten, D. M.; McElroy, M. B. (Kitt Peak National Observatory, Tucson, Ariz.). J. Geophys. Res.; 75: 4307-21 (1 Aug 1970).

The photochemistry and transport of N and NO are studied by means of a program incorporating molecular and eddy diffusion. The sources considered are ionospheric, and metastable reactants are included in order to match the large observed NO concentrations. With $O_2(^1\Delta)$ a satisfactory result can be obtained, but only with a rate coefficient 2 orders of magnitude larger than suggested by Norton found in the laboratory. The $N(^2D)$ is also satisfactory, and the required rate coefficients have some laboratory support. The $N(^2D)$ is taken to be produced by dissociative recombination of NO^+, and the yield is required to be between 0.5 and 0.6; the NO concentrations are very sensitive to the exact value in this range. An important new source of N (assumed to be ground state) is introduced: dissociation of N_2 by photoelectrons. The yield of $N(^2D)$ in NO^+ recombination must then be near unity. A possible consequence is an inverse dependence of D-region electron density on solar activity. It is pointed out that NO is determined by quite different factors during the polar night, and that much larger concentrations are plausible. (auth)

45104 TIME VARIATIONS OF RADIATION BELT PROTONS. Macy, William W. (Univ. of California, Riverside); White, R. Stephen; Filz, Robert C.; Holeman, E. J. Geophys. Res.; 75: 4322-8 (1 Aug 1970).

The time dependence of the flux of high-energy radiation belt protons at low altitudes is calculated for the time period 1961 to 1970. The calculations are made with a simple transport equation

that uses the variations of atmospheric density over this time period. The source, evaluated from experiment, may vary with altitude and energy and is taken to be independent of time. The time variation in the Earth's atmospheric density causes a change in the proton ionization loss and thus a change in the proton fluxes. The calculated variations in fluxes are in good agreement with experiments for 55-Mev protons at L = 1.4 at the altitudes of measurement of 440, 350, and 275 km. The theoretical ratios of the fluxes of 115- to 55-MeV protons are nearly within the uncertainties of the measured ratio of 0.46 ± 0.06 over this time period. The calculated ratios of the fluxes at 25 to the fluxes at 55 MeV deviate from a constant by a maximum of 12%. It is definitely established that the atmospheric density controls the time variations of the energetic trapped protons at low altitudes. (auth)

45105 MODEL STUDY OF PLASMAPAUSE MOTION. Grebowsky, J. M. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 4329-33(1 Aug 1970).

The ambient plasma in the equatorial plane is predominantly subject to the E × B drift. By approximating the earth's magnetic field by a dipole, characteristic steady-state streamlines in the equatorial plane are determined, assuming the interaction between the solar wind and the magnetosphere is characterized by a constant electric field directed from dawn to dusk in the equatorial plane. The steady-state plasmapause corresponds to the stagnation streamline in this flow. If the magnitude of the dawn–dusk field is suddenly increased, the plasmasphere bulge moves toward the sun. By suddenly decreasing the magnitude of this field, the bulge can be made to corotate with the earth. The model computations indicate that the spatial configuration of the plasmapause can be very complex, especially near the bulge, because its position depends upon the past history of the magnetosphere. (auth)

45106 ADIABATIC PRESERVATION OF GYROPHASE COHERENCE IN THE EARTH'S FIELD. Cornwall, John M.; Schulz, Michael (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 75: 4339-42(1 Aug 1970).

In the limit of adiabatic motion, the number of gyrations per bounce is so constant that the gyrophase (mod 2π) at which a particle crosses the equator advances by the same angular increment from each bounce to the next under azimuthal symmetry. Two particles that have the same three adiabatic invariants recover their initial gyrophase relationship after each bounce period. Gyrophase organization of particles that have the same three invariants is therefore able to survive several bounce periods of adiabatic motion, a result that may be important for triggered-emission and echo processes involving electron cyclotron waves. (auth)

45107 A COMPARISON OF THE OXYGEN ION–ION NEUTRALIZATION AND RADIATIVE RECOMBINATION MECHANISMS FOR PRODUCING THE ULTRAVIOLET NIGHTGLOW. Hanson, W. B. (Univ. of Texas, Dallas). J. Geophys. Res.; 75: 4343-6 (1 Aug 1970).

Recently, Knudsen suggested that oxygen ion–ion neutralization might provide an important contribution to the ultraviolet oxygen nightglow observed on Ogo 4. The relative contribution of this process is compared with that provided by radiative recombination, and it is concluded that radiative recombination should always be dominant, unless presently accepted values of the pertinent rate coefficients are in error. When the F-region electron concentrations are not abnormally large (i.e., $N_mF2 < 10^6$ cm^{-3}), the two mechanisms contribute comparable amounts of ultraviolet emission. It is also concluded that, unless certain of these coefficients are underestimated, the two mechanisms will not provide the observed intensity of the ultraviolet nightglow. (auth)

45108 INVESTIGATION OF THE RELATIONSHIP BETWEEN THE DRIFT OF SMALL-SCALE INHOMOGENEITIES OF THE IONOSPHERIC F2 LAYER AND CURRENT SYSTEMS IN THE DYNAMO REGION. Kashin, A. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 882-4(1969).

Translated from Geomagn. Aeron.; 9: 1088-90(1969).

Drift data obtained by the closely spaced reception method during the 8th and 9th Antarctic Expeditions at Mirny Observatory, the IGY and IQSY data at Moscow, and the 1966 to 1967 data at Tbilisi were analyzed to establish the relationship. The presence of a relationship between the variations of the H component and drift in the F2 region shows that the F2 region is put in motion as a whole by the dynamo field of the lower ionosphere. Results during the IGY and IQSY showed that solar activity affects mainly the conductivity of the ionosphere, and the variations of the H component and drift retain their pattern. (J.C.W.)

45109 STUDY OF LOW-ENERGY (20 TO 500eV) ION SOURCES FOR THE SIMULATION OF IONOSPHERIC FLIGHT. Marty, Denis; Pigache, Daniel (ONERA, Chatillon-Sous-Bagneux, France). pp 507-21 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

Two ion sources were investigated. One works with Mg ions and the other with Ar ions. Charge and current ionization of the ion beam results from electron emission from a filament passing through the beam at 1 cm from the source. The accelerating grid on the Ar source was encouraging. A great improvement was attained with the latter compared to a Hg source (stronger plasma flux, experimental jet more uniform and of larger diameter, and better simulation of ion mass and velocity). (France)

45110 PRODUCTION AND STUDY OF A SLOW-ION BEAM. Sautter, J. M.; Matthieussent, G. (Thomson–CSF, Centre de Recherches, Corbeville, France). pp 523-35 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

This work is concerned with the production of slow ion beams for ionospheric plasma simulation. An SD3–type CSF duoplasmatron with a special low-voltage, extraction system is used. Measurement of the beam characteristics has shown that this slow ion source is well adapted to the studies made and can easily be handled. (France)

45111 SOLAR WIND DEPENDENCE OF THE DIURNAL TEMPERATURE VARIATION IN THE THERMOSPHERE. Jacchia, Luigi G. (Smithsonian Institution, Cambridge, Mass.). J. Geophys. Res.; 75: 4347-9(1 Aug 1970).

The ratio $r = T_{max}/T_{min}$ of the maximum to the minimum exospheric temperature considered on a global scale was derived by means of static models using the densities obtained from the atmospheric drag of three low-inclination satellites. It is found that r varies with the solar cycle, lagging more than a year behind the variations of the 10.7-cm solar flux; on the other hand, the variations of r are in phase with $\bar{K}p$, which is obtained by averaging the planetary geomagnetic index Kp over the whole year. The obvious conclusion is that, in the mechanism of the diurnal temperature variation in the thermosphere, the solar wind may be at least as important as, if not more important than, solar euv. No appreciable lag is found in the variation of the minimum nighttime temperature when compared with the variations of the 10.7-cm solar flux. (auth)

45112 SYMPOSIUM ON THE APPLICATION OF ATMOSPHERIC STUDIES TO SATELLITE TRANSMISSIONS, BOSTON, MASSACHUSETTS, SEPTEMBER 3–5, 1969. Bowhill, Sidney A. (ed.). Radio Sci.; 5: 867-1005(Jun 1970). (CONF-690961).

Abstracts are presented for 14 of the 19 papers; the remaining 5 were not in scope of NSA. (J.C.W.)

For abstracts of individual papers see: 44894 and 45113–45125.

45113 TOTAL ELECTRON CONTENT STUDIES IN EQUATORIAL REGIONS. Hunter, A. N. (Univ. of Lancaster, Eng.). Radio Sci.; 5: 869-80(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

Current knowledge of the diurnal variation and spatial distribution of total electron content in the equatorial ionosphere are reviewed. The problems of data reduction peculiar to stations near the equator are considered. There is a large diurnal variation up to 40 : 1 that is greatest at the equinoxes and least in local winter. An "equatorial anomaly" in total electron content similar to the anomaly observed in f_0F_2 exists and is largely associated with the topside. Considerable differences in detail, particularly with regard to the time of disappearance of the anomaly, occur at different longitudes. Peaks of ionization have been observed around 2300 LT at about 26° of magnetic dip. Although little correlation has been found with magnetic activity on individual days, collective data indicate a reduction in the depth of the equatorial trough with magnetic disturbances, with the maxima occurring closer to the dip equator. More detailed work is indicated on the effects of longitude and magnetic activity, on the nighttime content, and on large-scale irregularities. (auth)

45114 NEUTRAL WINDS AND THE BEHAVIOR OF THE IONOSPHERIC F2 REGION. Cho, H. R.; Yeh, K. C. (Univ. of Illinois, Urbana). Radio Sci.; 5: 881-94(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

The continuity equation of ionization and the equation of motion of the neutral atmosphere are solved simultaneously in the ionospheric F2 region for different seasons in different epochs of solar activity. The model atmosphere used is that given by L. G. Jacchia (1965). Epstein functions are used to simulate the electron and ion temperature profiles. An ionization production function in a Jacchia model atmosphere is derived and used. The computed wind velocity and f_0F_2 behavior are presented and compared with other theoretical results as well as the existing experimental data. The meridional wind is found to agree reasonably well with the incoherent scatter data. It is found that the declination effect resulting from neutral winds can be used to explain certain experimental observations in a semi-quantitative manner. (auth)

45115 IONOSPHERIC STORMS AT MIDLATITUDES. Mendillo, M. (Boston Univ.); Papagiannis, M. D.; Klobuchar, J. A. Radio Sci.; 5: 895-8(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

The total electron content of the ionosphere often responds in a dramatic way to increases in geomagnetic activity. By monitoring vhf signals from the geostationary satellite ATS 3, it has been possible to study in detail the very pronounced increases in total content often found during the afternoon hours on the day of the commencement of a magnetic storm. Comparisons with magnetic field data show that the enhancements in electron content coincide with increases in the total magnetic field. This simultaneity suggests that, when the magnetosphere is compressed during the initial phase of a storm, the ionization stored in the magnetic tubes of force may be dumped into the topside of the F region. Such a depletion of the protonosphere is in agreement with whistler measurements, which indicate that a contraction of the plasmasphere occurs during periods of increased magnetic activity. (auth)

45116 LATITUDINAL VARIATION OF TOTAL ELECTRON CONTENT IN THE WINTER AT MIDDLE LATITUDES. Bertin, F.; Papet Lepine, J. (Faculte des Sciences, Paris). Radio Sci.; 5: 899-906(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

Studies of total electron content (TEC) were made by using data obtained during three winter solstices in Paris, France, and Kiruna, Sweden. A nocturnal winter maximum is clearly shown by these data, and an effort is made to hypothesize its cause. A two-fold hypothesis is offered; the increase in TEC is attributed to an electron flux descending from the protonosphere. This flux is linked to lowering electron temperatures in the force tube after sunset in the conjugate hemisphere. In addition to this production process, a regulatory process is invoked to reconcile the observed values with the maximum flux intensity compatible with the theory. The regulatory process is attributed to an interaction between the neutral winds and the ionospheric plasma in the presence of the earth's magnetic field. (auth)

45117 SIMULATION AND ANALYSIS OF FARADAY ROTATION OF BEACON SATELLITE SIGNALS IN THE PRESENCE OF TRAVELING IONOSPHERIC. Rao, Narayana N.; Hamrick, L. T. (Univ. of Illinois, Urbana). Radio Sci.; 5: 907-12(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

Records of Faraday rotation of signals from radio beacon satellites during traveling ionospheric disturbances are simulated for spaced stations. These synthetic records are used to discuss, first, observational differences using geostationary satellites and low-orbiting satellites and, secondly, the effect of assuming a height value for the disturbance in the analysis of the low-orbiting satellite data. (auth)

45118 INFLUENCE OF SOLAR ACTIVITY ON THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE OVER TORTOSA. Galdon, Eduardo; Alberca, Luis F. (Observatorio del Ebro, Tortosa, Spain). Radio Sci.; 5: 913-15(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

Through the use of the data obtained from the BE-B satellite, the effect of the solar cycle and the seasonal variation of the total electron content of the ionosphere are separated and evaluated. The results are compared with those of other authors. (auth)

45119 PROPOSAL FOR A NEW STYLE BEACON EXPERIMENT TO DETERMINE integralNds FOR THE IONOSPHERE AND MAGNETOSPHERE. Dieminger, W.; Hartmann, G. K.; Schmidt, G. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Radio Sci.; 5: 925-9(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

A new-style beacon experiment for measuring the difference-differential-Doppler (DDD) effect and the Faraday effect by using signals from geostationary satellites is proposed. By using the beacon frequencies of a geostationary satellite with frequency ranges $\geq$130 MHz, it can be shown that above 5000 km the upper atmosphere does not contribute measurably to the Faraday rotation angle. This is due to the weighting function of the Earth's magnetic field and the decrease in electron content with increasing altitude. The so-called differential Doppler is not affected by the above-mentioned weighting function, and therefore $\int$Nds is measurable along the total range up to 36,000 km, which is the distance of the geostationary satellite. In general, the Faraday rotation and the differential Doppler only display the variation of $\int$Nds as a function of time; e.g., the total amount of $\int$Nds is not known. By measuring the Faraday rotation on two closely spaced frequencies, however, one can calculate the total amount of $\int$Nds up to about 5000 km. This experiment was designed so that the DDD effect and the Faraday effect could be measured on two closely spaced frequencies. To measure the total electron content (TEC) up to 36,000 km, the following new method (DDD) is proposed: Over a time interval of approximately 4 minutes, the beacon frequency of 138 MHz is slowly shifted to 137.5 MHz and then slowly back to 138 MHz; simultaneously, the frequency 414 MHz is shifted to 412.5 MHz and back to 414 MHz. By designing an appropriate phase-locked receiving system, it seems possible to measure the so-called difference-differential Doppler with an accuracy of better than 5%, e.g., to calculate the total amount of $\int$Nds from 0 to 36,000 km. No other known method can achieve such an accuracy. The effective radiated power of the satellite antenna never exceeds 1 watt. Taking into account navigation systems, $\int$Nds represents, apart from a constant well-known factor, the total range error that is due to the ionosphere and magnetosphere. Measurements of the Faraday effect and differential-Doppler effect (137.350 and 412.050 MHz) with signals from the ATS-3 satellite displayed very sensitively traveling ionospheric disturbances (TID) at the observing station in Lindau. By using several reasonably located observing stations, dynamic processes (TID) in the upper atmosphere might be easily investigated. Regardless of whether it will be possible to determine accurately the exospheric electron content and whether this proposal will be accepted, there is an absolute necessity for any measuring method that yields $\int$Nds with a much higher accuracy than can be determined by the presently used methods. The determination of $\int$Nds is required with at least the above-mentioned accuracy for any thorough investigation of so-called occultation experiments. Comparisons with other methods in use for calculating $\int$Nds are presented, e.g., regular group-delay measurements. The proposed method seems to yield the most accurate measurements possible for these particular experiments. It is very likely that from a technical point of view the accuracy is greater than can be obtained with the group-delay methods now used. From a theoretical point of view, however, the degrees of accuracy obtained by the two methods are comparable. (auth)

45120 EQUATORIAL F-LAYER IRREGULARITY EXTENT AS OBSERVED FROM HUANCAYO, PERU. Bandyopadhyay, P. (Instituto Geofisico del Peru, Huancayo); Aarons, Jules. Radio Sci.; 5: 931-8(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

Simultaneous observations of propagation paths to two synchronous satellites transmitting at 137 MHz have revealed distinctive characteristics of the equatorial irregularity structure. Data were taken between July 1967 and February 1969. The abrupt onset of scintillations on a particular path within minutes led to the concept that a sharp boundary of about 10 km exists between quiet nonscintillating regions and regions of irregularities. Once the scintillation has started, a region over 5000 km wide from east to west may contain irregularities. Within such a region there is strong localized control of irregularities. Comparison of scintillation onset on two paths spaced 1 to 2 hours apart at their subionospheric points reveals that, in the mean, scintillation onset is a function of local time. However, many days show nearly simultaneous onset on two paths that are 1 hour apart in local time. Other days show onset of scintillations on the westerly satellite path before onset at the eastern intersection; this variability is clearly a negation of the diurnal pattern. Maximum occurrence of scintillation has been observed in September, October, and November. A somewhat lower occurrence of high-amplitude scintillation is noted in the December to January solstice period. A secondary maximum exists in March, according to other South American data. A very low occurrence of scintillation is observed in May, June, and July. The scintillation phenomenon is correlated in the mean with the downward motion of the F layer after 2100 local time at Huancayo. A hypothesis is advanced that after 2100 the westerly F-layer maximum is higher

in altitude and has a greater electron density than the easterly maximum. This west–east gradient of electron density produces (either through electrodynamic forces or diffusion) the irregularities that show an apparent eastward drift. The diurnal pattern, with its nighttime maximum of scintillation occurrence, is a westward motion, but the irregularity drifts noted are clearly eastward in the direction of lower electron density profiles. (auth)

45121 STUDIES ON F-REGION IRREGULARITIES AT LOW LATITUDE FROM SCINTILLATIONS OF SATELLITE SIGNALS. Bhar, J. N.; Das Gupta, A.; Basu, S. (Inst. of Radio Physics and Electronics, Calcutta). Radio Sci.; 5: 939-42(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

The characteristics of F-region irregularities at low latitudes were studied from scintillations of signals from beacon satellites having different orbital inclinations. It was found that the irregularities are embedded in distinct N–S-oriented clouds. A comparison of the experimental and theoretical results of scintillation was made to determine the parameters of the irregularities. (auth)

45122 40-MHz IONOSPHERIC SCINTILLATION AND THE SPORADIC-E LAYER. Anastassiadis, Michael (Univ. of Athens); Matsoukas, Dimitris; Moraitis, George. Radio Sci.; 5: 953-7(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

Simultaneous observations of minute-by-minute ionograms and signal-amplitude recordings from Explorer 22 (BE-B) have shown a marked coincidence of high scintillation indices and a height spreading of the sporadic-E trace. These observations, made at Athens (37°58′N, 23°43′E) over a period of 18 months, lead to the conclusion that the existence of spreading is usually associated with strong scintillation. (auth)

45123 HIGH-LATITUDE F-REGION IRREGULARITY STRUCTURE DURING THE OCTOBER 30–NOVEMBER 4, 1968, MAGNETIC STORM. Aarons, Jules (Air Force Cambridge Research Labs., Bedford, Mass.). Radio Sci.; 5: 959-66(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

A study of multistation scintillation observations of the 137-MHz transmissions from ATS-3 during the magnetic storm of October 30 to November 4, 1968, was made to separate the diurnal pattern of high-latitude irregularities from storm-time effects. The night maximum was maintained during magnetic storms, but the pattern was modulated by storm-time effects. Daytime scintillation indices were increased at specific times during the magnetic storm; a universal time correlation was observed for stations in Europe and in North America. Peak scintillation activity shifted from before midnight (under quiet magnetic conditions) to the 0130 to 0430 time period. A sharp boundary of less than 2° was noted between scintillating and non-scintillating regions. 40-MHz transmissions from Explorer 22 during one period of the storm verified that the irregularity structure extended from 48° to 50° GN to auroral latitudes. Using records of 54-MHz transmissions from Transit 4A taken between 1962 and 1965, as well as the ATS-3 data, it was found that during magnetic storms the lower edge of the scintillation boundary, which bounds the irregularity structure, moves below its quiet positions to lower latitudes, particularly in the midnight-to-dawn time period. It was found that the observations were more adequately ordered by invariant latitudes than geomagnetic (dipole) latitudes used in scintillation papers. Latitude variations in position of the boundary are compared with the trough. It is found that the irregularity-boundary changes as a function of K index and as a function of local time. Akasofu's concept of nearly open field lines in the plasmapause during magnetic storms might account for the increased scintillation indices as well as for the lower position of the scintillation boundary during magnetic storms. (auth)

45124 MEASUREMENT OF IRREGULARITY HEIGHTS BY THE SPACED-RECEIVER TECHNIQUE. Paul, L. M.; Yeh, K. C.; Flaherty, B. J. (Univ. of Illinois, Urbana). Radio Sci.; 5: 967-73(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

The scintillation of radio signals from an artificial earth satellite was analyzed by spaced-receiver techniques to obtain the heights of the electron density irregularities responsible for scintillations observed at the ground. Data taken near the maximum of the present solar cycle are compared with results of data taken near the minimum phase of the solar cycle. Eighty-four passes of BE-B extending from January 1968 to July 1968 were reduced for height values. The heights were computed by measuring the time delays in the ground pattern by graphical cross-correlation techniques. These delays were then substituted into a height equation for a spherical earth and ionosphere. The spherical formula was developed so that height values for sub-ionospheric latitude from 36° to 50°N could be measured. The diurnal behavior and the latitude dependence of irregularity height are studied and compared with results obtained during the solar minimum. (auth)

45125 HEIGHTS OF IONSOPHERIC IRREGULARITIES AT A SUB-AURORAL LATITUDE. Kidd, William C. (Air Force Cambridge Research Labs., Bedford, Mass.). Radio Sci.; 5: 975-8(Jun 1970).

From Symposium on the Application of Atmospheric Studies to Satellite Transmissions, Boston, Mass. See CONF-690961.

The heights of ionospheric irregularities were measured at the Sagamore Hill Radio Observatory, 42.6°N, 70.8°W. Beacon signals at 40.01 MHz from Explorer 22 were recorded at spaced receivers during the summer and fall of 1968 and during a short period in the winter of 1969. By using the mean time differences between 1-second samples at each receiver and by using the method of similar fades, the heights of dominant irregularities were found to vary between 130 and 900 km. Scale size (determined from the height measurement and the time between major peaks of the diffraction patterns) increased from 1 km at a height of 200 km to 4 km at a height of 800 km. Two large geomagnetic storms occurred during the test periods. Results were compared with simultaneous measurements of total electron content. The mean height of the irregularity region decreased by 100 km during periods of major depression of total electron content; this decrease suggests that the irregularities are distributed throughout the F region for both quiet and disturbed conditions. (auth)

45126 NIGHTTIME RESPONSE OF THE TOPSIDE IONOSPHERE TO MAGNETIC STORMS. Lakshmi, D. R.; Reddy, B. M. (National Physical Lab., New Delhi). J. Geophys. Res.; 75: 4335-8(1 Aug 1970).

Study of the topside ionosphere during magnetic storms by using simultaneous measurements of electron density and electron temperature has revealed that the behavior of the topside ionosphere is entirely different from that of either the bottomside ionosphere or the magnetosphere. Considerable electron density enhancements with a seasonal bias are observed during nighttime. The day–night comparison of storm time variations shows an extremely interesting feature in that the seasonal bias is exactly reversed. Electron temperature variations are not so marked except for the increasing trend at high latitudes. (auth)

45127 LONGITUDINAL VARIATION OF ELECTRON DRIFT VELOCITY IN THE EQUATORIAL ELECTROJET. Balsley, Ben B. (ESSA Aeronomy Lab., Boulder, Colo.). J. Geophys. Res.; 75: 4291-7(1 Aug 1970).

Measurements of electron drift velocity in the equatorial electrojet near the Peruvian coast indicate that the velocities to the west of the observatory are normally greater than those to the east. This is true during the day when the electrons are drifting westward, as well as at night when the drift is reversed. Possible explanations include the effect of the underlying land-sea boundary about 35 km west of the observatory and small local magnetic anomalies that alter the local dip angle. (auth)

45128 GEOMAGNETIC CONJUGACY VARIATIONS. Mendis, D. A.; Axford, W. I. (Univ. of California, San Diego). Comments Astrophys. Space Phys.; 2: 99-108(May-Jun 1970).

It is concluded that it is possible to understand qualitatively why there should be variations of conjugacy, which effects are likely to be most important, and where the most pronounced variations are likely to occur. It is less certain, however, that credible quantitative results can be obtained with reasonable effort, and at present it is not entirely obvious what the significance of such results might be. (W.D.M.)

45129 MAGNETO-METEOROLOGY: ATMOSPHERIC EFFECT ON THE EARTH MAGNETIC FIELD AND ITS CONSEQUENCES. Bernard, P. (Paris Univ.). Rev. Phys. Appl.: 5: 239-41(Feb 1970). (In French).

For the explanation of the undecennial and biennial periods of H (horizontal geomagnetic force), ionospheric winds are considered in a transition layer (90 to 120 km height) where positive ions are carried along by their impacts with neutral atoms, while negative electrons are inhibited to move perpendicularly to the geomagnetic field. The wind is therefore in this case equivalent to an electric current. The actual amplitudes of the variations of H agree with the known data at these heights. The formation of a transition layer in a very small magnetic field is discussed: it can give rise,

for convenient velocities and directions of wind, to a much stronger field that will become permanent if it occurs during the cooling of the Earth's crust. It is suggested that the magnetic fields in Sun and other celestial bodies result from a similar mechanism. (tr-auth) (France)

45130 STATISTICS OF TROPOSPHERIC ATTENUATION AT 190 GHz FROM OBSERVATIONS OF SOLAR NOISE. Davies, P. G.; Lane, J. A. (Radio and Space Research Station, Slough, Eng.). Electron. Lett.; 6: 522-4(6 Aug 1970).

Data are given of the total attenuation in the troposphere as determined by radiometric measurements at Slough over the period June 1968 to December 1969. At a zenith angle of about 70°, the attenuation exceeds approximately 1.5, 5, and 12 dB for 1, 0.1, and 0.01% of the time, respectively. (auth) (UK)

45131 MULTIPLE REFLECTION PROCESSES IN THE D AND E REGIONS AT LOW AND VERY LOW FREQUENCIES. Altman, C.; Cory, H. (Technion–Israel Inst. of Tech., Haifa). J. Atmos. Terrest. Phys.; 32: 1439-55(Aug 1970).

D-region reflection and transmission coefficients for lf and vlf electromagnetic wave propagation at vertical incidence are determined as a function of frequency by means of a full-wave method, and the mechanism of formation of minima and maxima in the frequency spectrum is discussed by means of a simple thin-film optical (or multiple reflection) method which shows the detailed contribution of each ionospheric segment to the overall propagation characteristics. The role of multiple reflections is demonstrated by determining the error introduced by a first order calculation of reflection coefficients and by the WKB calculation of transmission coefficients. The fine structure in the frequency variation of the transmission coefficient, such as the formation of maxima and minima, is shown to be correlated with the fine structure in the frequency variation of the reflection coefficient only if the wave absorption is low, since the former is determined primarily by a second order reflection process whereas the latter by a first order process and the different pattern of absorption of the partially reflected wavelets in each case is responsible for the different interference patterns which result. (auth) (UK)

45132 POSSIBLE INFLUENCE OF MAGNETIC ACTIVITY ON ATMOSPHERIC ELECTRIC PARAMETERS. Rao, Manoranjan (Nagoya Univ., Toyokawa, Japan). J. Atmos. Terrest. Phys.; 32: 1431-7(Aug 1970).

The potential gradient and air–earth conduction current density measurements made simultaneously at Payerne and Murchison Bay during the periods July to October 1957 and July to October 1958 were analysed to yield what is believed to be an indirect evidence of the influence of the geomagnetic activity. (auth) (UK)

45133 MEASUREMENT OF ABSORPTION IN THE IONOSPHERE ON 27.6 MHz AT 52°N BY MEANS OF A RIOMETER AND A CORNER REFLECTOR ANTENNA DIRECTED TO THE POLE STAR. Schwentek, H.; Gruschwitz, E. H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 32: 1385-1402(Aug 1970).

Since January 1965, at Lindau (51.6°N; 10.1°E), the cosmic noise has been recorded continuously by a riometer mainly to determine absorption in the ionosphere. By means of a corner reflector antenna directed to the Pole star the sidereal variation of the cosmic noise could be reduced to be less than ±4% of the mean value. The diurnal variation of absorption L(27.6 MHz) can be described by $L(t + \tau) = L_0 \cos^n \chi(t)$; τ = 0 to 60 min, n = 0.7 to 1.1 in Summer, n = 0.4 to 0.8 in Winter. The seasonal variation of absorption shows a clear winter anomaly in both the subsolar absorption L_0 and in the absorption at a constant solar zenith angle L(cos χ = 0.25). A variation of absorption with sunspot number has also been identified. The observed influence of the F2-layer on absorption is due to a "window effect" beginning at f_0F2 = 7.5 MHz. The correlation between L (27.6 MHz) and L(2.61 MHz) is not very distinct and will be a subject of further investigation. To ensure complete suppression of the sidereal variation a better corner reflector antenna is being constructed. (auth) (UK)

45134 COUPLING PROCESSES IN THE D AND E REGIONS AT LOW AND VERY LOW FREQUENCIES. II. FREQUENCIES GREATER THAN CRITICAL: A STUDY OF THE NIGHT-TIME IONOSPHERE. Altman, C.; Fijalkow, E. (Technion–Israel Inst. of Tech., Haifa). J. Atmos. Terrest. Phys.; 32: 1475-88 (Aug 1970).

The generalised thin-film optical method is used to analyze propagation phenomena in a typical nighttime ionosphere at frequencies in the range 10 to 300 kHz, the critical frequency being 24 kHz. Propagation phenomena in the vlf and lower lf range take place in conditions of limiting polarisation, so that the composite or physical waves pass quite smoothly through the X = 1 level and other regions of rapidly varying polarization, even at the critical frequency. In such cases the inter-mode coupling coefficients attain very large values which are just sufficient to produce the requisite mode reshuffling to maintain composite waves of almost constant polarisations and amplitudes. The low values of electron density in the D-layer lead to large departures from quasi-longitudinal (Q.L.) propagation conditions, which are generally reestablished, however, in the region of large and rapid increase of electron density at the top of the D-layer. This leads to mode reshuffling, and if the X = 1 level is at a somewhat greater altitude the coupled ordinary wave may then be reflected at the X = 1 level to produce effects analogous to the Z-coupling echo and the Z-trace. In the upper lf range the inter-mode coupling processes associated with the rapid variation of wave polarisation at the X = 1 level are suppressed by an interference process so that mode reshuffling is eliminated, and an initial extraordinary wave follows the characteristic polarisation reversal at the X = 1 level with little loss. (auth) (UK)

45135 COUPLING PROCESSES IN THE D AND E REGIONS AT LOW AND VERY LOW FREQUENCIES. I. FREQUENCIES LESS THAN CRITICAL: A STUDY OF THE DAYTIME IONOSPHERE. Altman, C.; Cory, H.; Fijalkow, E. (Technion–Israel Inst. of Tech., Haifa). J. Atmos. Terrest. Phys.; 32: 1457-73(Aug 1970).

Use is made of a generalized numerical method of thin film optics to derive 2 × 2 reflection and transmission coefficient matrices of horizontal ionospheric slabs, the top ends of which become progressively higher. The matrix elements are expressed in terms of characteristic magneto-ionic modes, off-diagonal elements representing inter-mode coupling terms. Propagation processes in the frequency range 10 to 200 kHz are followed by presenting the various matrix elements graphically as functions of the ionospheric slab height. In the vlf range direct (gradient) reflections of the ordinary wave and the Z-trace reflection processes are competitive, but in the lf range the Z-trace is the main process reflecting ordinary wave energy. The "coupling echo" whereby the upgoing ordinary wave is converted to downgoing extraordinary at the X = 1 level (when $Z \approx Z_c$), is almost nonexistent, but there is a strong "Z coupling echo" produced by the reflection at the X = 1 + Y level of an extraordinary wave generated near the X = 1 level by an upgoing ordinary wave. The same process taken backwards, with upgoing extraordinary returning as ordinary is, by reciprocity, of equal magnitude. The "inverse Z-transmission" process, with upgoing extraordinary being coupled into upgoing ordinary at the X = 1 level is very weak. It is shown that a wave of arbitrary polarization, incident on the ionosphere from below, will tend to maintain its initial polarization well into the ionosphere, even though the characteristic local wave polarization may have changed considerably. In the upper lf range, where the X = 1 + Y level is virtually the only reflection region, a number of simple relations are shown to exist between the various transmission and reflection coefficient matrix elements. The problem of nomenclature of characteristic magneto-ionic modes at frequencies "less than critical" is discussed. (auth) (UK)

45136 OBSERVATIONS OF LOW-FREQUENCY MICROPULSATIONS AT A MODERATE LATITUDE. Duffey, R. B. (Univ. of Exeter, Eng.). J. Atmos. Terrest. Phys.; 32: 1345-63(Aug 1970).

A sensitive two-component induction magnetometer was constructed for the recording of geomagnetic micropulsations at a site near 54°22′N. An analysis of micropulsations in the IAGA categories Pc3, Pc4, and Pi2 was developed for the six-month interval April to September, 1966. The occurrence probabilities and other characteristics of these micropulsations are discussed in detail. The Pc exhibit clear diurnal frequency and occurrence variations, and changes in these parameters with the local K index were found. The occurrence of Pi2 is also strongly dependent on local geomagnetic activity. (auth) (UK)

45137 ASPECTS OF THE IONOSPHERE. Rawer, Karl (Ionosphaeren-Institut, Breisach, Ger.). Ann. Geophys.; 26: 95-107(1970).

A broader point of view is now taken by researchers in the ionosphere. The electronosphere is being completed by including ion chemistry and the effects of temperature variation. The phenomena of motion and turbulence have regained much interest, as have possible reactions between the ionosphere and the magnetosphere or stratosphere. (tr-auth) (France)

45138 INVESTIGATION OF NIGHTTIME IONIZING SOURCES IN LOW- AND MID-LATITUDES. Tohmatsu, Takao (Tokyo Univ.); Wakai, Noboru. Ann. Geophys.; 26: 209-11(1970).

The photoionizing effect of the hydrogen ultraviolet geocorona on the nighttime ionosphere was studied. The vertical distribution of the electron density in the E region under the influence of geocoronal Ly-β irradiation was calculated and compared with those obtained from the analysis of the medium-frequency ionosonde data. It was found that the maximum electron density of the E region can be maintained above the value of 3×10^3 el/cm^3 throughout the night as the Ly-β photoionizes molecular oxygen selectively. It was shown also that the E-region electron density varies with local time as expected from the change of the Ly-β irradiance with the solar elongation. (tr-auth) (France)

45139 INDIRECT DETERMINATION OF THE ENERGY CHARACTERISTICS OF DAILY ELECTRON PRECIPITATIONS INSIDE THE AURORAL ZONE. Maral, G. (Univ., Toulouse). Ann. Geophys.; 26: 71-9(1970). (In French).

Measurements of atmospheric bremsstrahlung from precipitated electrons were made in the 15- to 150-keV range using a collimated detector and a 128-channel spectrum analyzer, carried by a balloon. The results obtained were used to estimate the primary energy spectra of the precipitated electrons at different local times. The electron energy spectrum can be described by an exp (–T/TOE) function. During the day, the TOE increases from ~20 keV in the morning to 45 keV in the afternoon. This variation of the TOE and the variation of the precipitation time-structure with local time confirm a diurnal precipitation cycle related to the Earth rotation in the magnetosphere. Late morning precipitations sometimes exhibit intense bursts with typical durations of ~200 ms whose energy distributions are the same as that of the auroral x-ray background spectrum. It is concluded that microbursts are probably caused by perturbations in the auroral background localized between 2500 and 7500 km above the Earth. (tr-auth) (France)

45140 METALLIC ATOMS AND IONS IN THE UPPER ATMOSPHERE. Gadsden, M. (Environmental Science Services Administration, Boulder, Colo.). Ann. Geophys.; 26: 141-50(1970).

A model of the concentrations of metallic atoms and ions in the upper atmosphere is obtained from a simplified diffusion equation, taking account of the deposition of atoms from ablating meteors and the subsequent ionization of these atoms. An infinite sink for atoms and ions is assumed for the lower boundary condition: the sink is possibly identifiable with the region of the atmosphere containing water vapor. Sweeping of the ions downwards, out of the region, is taken into account. The predictions of the model are compared with observational data, and lead to the probability of control mainly by diffusion processes, rather than by ionization or horizontal global transport. Restrictions are found on the amount and type of meteor flux, in the atmosphere, which are necessary to give the sodium layer that is observed. (tr-auth) (France)

45141 ABSOLUTE ACCURACY OF THE FARADAY METHODS IN THE CALCULATION OF THE TOTAL ELECTRON CONTENT. Thomas, Georges (Univ., Paris). Ann. Geophys.; 26: 81-93(1970). (In French).

The Faraday methods are based upon a number of simplifying hypotheses, thus some uncertainty exists in the calculation of the total electron content (TEC). This uncertainty is determined from the comparison of simultaneous measurements by the Faraday methods and ionospheric sounding from the bottom and top sides. A method is suggested giving the value of TEC from a single frequency recording, which is in good agreement with the value obtained using two adjacent frequencies. It is emphasized that the elevation angle of the satellite, and the variation of the efficiencies of the various layers with respect to their heights influence the calculated value of TEC. An improved method for determining the height at which "M" should be calculated is realized; this allows a more efficient utilization of the Faraday effect. It is concluded that the Faraday methods yield results for TEC which are comparable to those from other methods. (tr-auth) (France)

45142 MAGNETOSPHERIC PROCESSES LEADING TO MID-LATITUDE AURORAS. Cole, K. D. (La Trobe Univ., Victoria, Australia). Ann. Geophys.; 26: 187-93(1970).

During magnetic storms normal auroras occur frequently on closed geomagnetic field lines. This indicates that reconnection of magnetic field lines is not necessarily required in the auroral acceleration process. Dynamical processes leading to the formation of magnetosphere ring current are considered. Power spectrum analyses of geomagnetic data in the period ranges 5 to 75 minutes from stations distributed over the Earth during the onsets of two magnetic storms were carried out. In these two storms the ring current is formed on the lowest L shells of the heavily disturbed portion of the magnetosphere. This is consistent with an earlier prediction (Cole, 1964). The decay of energy of the inflated magnetosphere and its consequences for the atmosphere are discussed. The current state of knowledge of stable auroral red arcs and other thermal auroral situations is reviewed. No observations exist that deny the validity of the heat conduction hypothesis for explaining thermal auroras in midlatitudes, in particular SAR-arcs. (tr-auth) (France)

45143 EMPIRICAL LAWS RELATING THE ELECTRON TEMPERATURE AND DENSITY IN THE F LAYER OF THE IONOSPHERE. Lejeune, G.; Waldteufel, P. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Ann. Geophys.; 26: 223-7(1970). (In French).

Using data of the incoherent scatter experiment of Saint Santin-Nançay, it is shown that empirical laws can be found relating electron and ion temperatures and electron density in the F region during sunspot maxima. The interest of such laws and their possible extension are discussed. (tr-auth) (France)

45144 EXPLOSIONS IN AN IONOSPHERE WITH FINITE ELECTRIC CONDUCTIVITY IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD. Cap, Ferdinand F. (Univ., Innsbruk). Z. Flugwiss.; 18: 98-100(Feb-Mar 1970).

The problem of detecting nuclear explosions in space by recording perturbations of the magnetic field of the Earth is mathematically presented. A blast wave in an ionosphere with finite electric conductivity, heat conduction, and viscosity is not a shock, but a smooth, continuous steep pressure wave described by the equations of continuity, MGD-Stokes–Navier, induction, and the energy theorem. Introducing spherical coordinates with the polar axis in the direction of the exterior uniform magnetic field, it is assumed that $\partial/\partial\varphi = 0$. Six nonlinear partial differential equations for the six dependent variables of density, radial and azimuthal flow velocity, pressure, and magnetic field as functions of three independent variables are developed. The system may be integrated numerically by a computer using an MHD-characteristics method for plasmas with finite electric conductivity. (J.C.W.)

45145 ORIGIN OF NITRIC OXIDE IN THE TERRESTRIAL ATMOSPHERE. Nicolet, M. (Institut d'Aeronomie Spatiale, Brussels). Planet. Space Sci.; 18: 1111-18(Jul 1970).

It is suggested that the nitric oxide in the mesosphere and stratosphere is due to a downward transport from the thermosphere above the E-layer where it is produced. An estimate of the diffusion time demonstrates that the nitric oxide concentration in the lower thermosphere (in the E-layer) depends on its downward transport by molecular diffusion in the F-layer and is greater than the photochemical value. In the lower thermosphere the downward current of NO molecules depends on the value of the eddy diffusion current. In any case, this current is to replace the nitric oxide molecules destroyed through the photodissociation in the mesosphere. In the stratosphere the final sink of NO (and NO_2) is the formation of HNO_2 and HNO_3 by reactions with HO_2 and H_2O_2 since no photodissociation process occurs below the stratopause. A small eddy diffusion coefficient is required. (UK)

45146 FORMATION OF STRIATIONS IN ARTIFICIAL ION CLOUDS. Reid, George C. (Univ. of Colorado, Boulder. ESSA Research Labs., Boulder, Colo.). Planet. Space Sci.; 18: 1105-6(Jul 1970).

The measurement of large-scale electric fields in the ionosphere and magnetosphere has recently been carried out by observing the drift velocities of artificial ion clouds. The standard technique involves releasing quantities of barium ions into late twilight conditions and observing the subsequent motions of the ions optically through resonance scattering of sunlight. Many of the ion clouds develop pronounced striations aligned with the local geomagnetic field. It is pointed out that the striations probably give a visual indication of the process of small-scale electric-field transfer along the magnetic field, and are probably not the result of an instability occurring in the vicinity of the cloud itself, at least in the case of low-density releases in which the artificial ion density is considerably less than that of the ambient ionosphere. The author infers that some source mechanism, probably in the dynamo region of the ionosphere, creates small-scale electric fields that are conducted along the magnetic field lines and generate striations in artificial ion clouds released at F-region heights. The nature of the source mechanism is not immediately identifiable. (UK)

45147 IONOSPHERIC WIND DYNAMO. II. SOLAR TIDES. Tarpley, J. D. (National Center for Atmospheric Research, Boulder, Colo.). Planet. Space Sci.; 18: 1091-1103(Jul 1970).

The electric currents generated in the ionosphere by the important solar diurnal and semidiurnal tidal modes are investigated. The currents produced by the solar diurnal (1,3), (1,–1), and (1,–3) modes and the solar semidiurnal (2,2) and (2,4) modes are calculated. The solar diurnal (1,3) mode, which is prominent in the E

region, produces very little current. The fundamental solar diurnal mode, the (1,–1) mode, generates currents that resemble the S_q current pattern. The theory of the ionospheric dynamo and the calculated electric current patterns produced by the lunar atmospheric tide (Tarpley, 1970) are used here to investigate the geomagnetic effects of the various solar tidal modes. (auth) (UK)

45148 IONOSPHERIC WIND DYNAMO. I. LUNAR TIDE. Tarpley, J. D. (National Center for Atmospheric Research, Boulder, Colo.). Planet. Space Sci.; 18: 1075-90(Jul 1970).

The differential equation describing the response of the ionosphere to a horizontal wind-induced emf is derived and the appropriate boundary conditions are discussed. The equation is solved numerically to obtain the electric current distribution produced by several different models of the lunar semidiurnal tide. Tidal wind systems with large vertical wavelength are found to be much more efficient producers of current than wind systems of short wavelength. The current patterns produced by the lunar (2,2) mode with a maximum amplitude of 7.5 m/sec and a vertical wavelength of 85 km are very similar to the L current patterns deduced from geomagnetic observations. (auth) (UK)

45149 DIURNAL PHASE ANOMALY IN UPPER ATMOSPHERIC DENSITY AND TEMPERATURE. Chandra, S. (Goddard Space Flight Center, Greenbelt, Md.); Stubbe, P. Planet. Space Sci.; 18: 1021-33(Jul 1970).

The heat conduction equation for the neutral atmosphere in the region between 120 to 1500 km is solved using the concept of dynamic diffusion. It is shown that the present discrepancy in the phase and the diurnal amplitude of the thermospheric temperatures as inferred from incoherent backscatter and satellite drag measurements can be fully reconciled by such an approach. The numerical solutions show that the phase and the diurnal amplitude of the atmospheric density in the region between 200 to 500 km are in accord with the satellite drag results; the corresponding neutral temperature, however, follows the diurnal pattern inferred from the backscatter technique. The characteristics of the density variations above 500 km strongly depend upon the choice of the hydrogen and helium models and their relative concentration. In the region where hydrogen becomes a dominant constituent, the density reaches its maximum value in the nighttime and its minimum in the daytime. The physical basis for the dynamic diffusion is discussed, and it is suggested this should replace the conventional static diffusion models in computing temperatures from the atmospheric densities obtained from satellite drag measurements. (auth) (UK)

45150 MOTION OF ARTIFICIAL ION CLOUDS IN THE MAGNETOSPHERE. Scholer, Manfred (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Planet. Space Sci.; 18: 977-1004(Jul 1970).

An artificially created ion cloud is assumed to have a relative velocity with respect to the ambient plasma originating from the momentum of the satellite from which the cloud is released and because of the convection of the magnetospheric plasma itself. The process of momentum exchange between the cloud and the plasma contained in the flux tube through the cloud is investigated. The cloud's motional electric field is transferred with Alfvén velocity along the field lines and accelerates the magnetospheric plasma. The electric field reaches ultimately the ionosphere where it generates a conduction current. However the electric field, which can be applied to the ionosphere, may be smaller than the original field because of the polarizing effect of the Pedersen current. Therefore, part of the electric field will be reflected. The reflected part can generate after arriving at the cloud a further deceleration of the cloud, depending on the high-integrated Pedersen conductivity of the ionosphere. (auth) (UK)

45151 FOCUSING OF RADIO WAVES REFLECTED FROM THE IONOSPHERE AT LOW ANGLES OF ELEVATION. Bradley, P. A. (Radio and Space Research Station, Slough, Eng.). Electron. Lett.; 6: 457-67(23 Jul 1970).

The mechanisms by which radio waves reflected from the ionosphere experience focusing are discussed. Calculations of this focusing are presented for oblique propagation at low angles of elevation via the E and F layers, and curves for use in prediction studies are given. (auth) (UK)

45152 HORIZONTAL TRAVELLING WAVES DURING THE ONSET OF MAGNETIC STORMS. Anastassiades, M. (National Observatory, Athens); Moraitis, G.; Anastassiades, A. Nature (London); 227: 479-80(1 Aug 1970).

It is stated that the close relation between the occurrence of horizontal ionospheric wave disturbances and the onset of magnetic storms suggests that energy deposited in the neutral gas during such storms is radiated in the form of atmospheric gravity waves. A sudden magnetic storm commencement recorded near Athens on March 23, 1969 was followed by an unusual occurrence of nighttime sporadic E that produced complete occultation of the F layer. The magnetic storm may have been associated with a solar flare of magnitude 3 recorded on the same day, and the unusual occurrence of sporadic E over Athens may have been related to the survival of a solar corpuscular emission 12 hrs later. The starting and end moments of the sudden injection of the corpuscular emission into the ionospheric plasma could be determined from the continuous recording obtained by the ionosondes. This injection was followed by F-region oscillations that could be observed only after disappearance of sporadic E. It was indicated that a clear displacement of ionisation occurred and not the creation of an additional ionisation. The corpuscular injection to the neutral gas produced a horizontal travelling wave recorded by the ionosonde as a displacement of ionisation, and the wavelength and period of this travelling disturbance suggested that atmospheric gravity waves were responsible for the transport of ionisation. (UK)

45153 OBSERVATIONS OF HIGH-FREQUENCY MICROPULSATIONS AT A MODERATE LATITUDE. Duffey, R. B. (Univ. of Exeter, Eng.). J. Atmos. Terrest. Phys.; 32: 1365-83(Aug 1970).

Micropulsations in the IAGA categories Pc1, Pc2, and Pi1 were studied during the six-month interval April to September, 1966, using a two-component induction magnetometer at a site near 54° 22′N. Several micropulsation types distinct in their observational characteristics and in their relation to local geomagnetic activity are discussed. A preliminary analysis is given of pearl-type Pc1 and a new low-level continuous micropulsation Pc1, 2 is examined. The latter has an occurrence probability negatively correlated with increasing values of the local K index. Pc2 micropulsations common during magnetically disturbed intervals are discussed, and are shown to have an occurrence probability positively correlated with increasing values of the local K index. Regular riders accompanying Pi2 are interpreted as being Pc2. (auth) (UK)

45154 THEORETICAL CALCULATIONS OF THE PRE-DAWN ENHANCEMENT. Sudworth, J. P. (Royal Aircraft Establishment, Farnborough, Eng.). Planet. Space Sci.; 18: 1011-20(Jul 1970).

Theoretical calculations show that the pre-dawn enhancement of the oxygen red lines is caused by photoelectrons from the magnetic conjugate region with energies of a few tens of electron volts. The calculated intensities agree very well with observation. The incoming photoelectrons also produce a significant amount of ionisation in the nighttime F region. (auth) (UK)

45155 CORRELATION ANALYSIS OF RADIO-AURORAL SCATTER SIGNALS. Palmer, F. H.; Moorcroft, D. R. (Univ. of Western Ontario, London). Can. J. Phys.; 48: 1716-23(15 Jul 1970).

Very-high-frequency radio-auroral scatter signals are regularly observed on an Ottawa–London (Ontario) backscatter circuit operating at 40.35 MHz. For three of these events the scale size and drift velocity of the scattered field at the receiving site were determined by a correlation analysis of the signals received at spaced antennas. The overall east–west extent of the scattering regions was determined from the scale-size measurements. At least two types of event were observed. One type results from scattering by extended regions with horizontal dimensions greater than 200 km and having minimum drift velocities of a few hundred m/s. The second type of event results from simultaneous scattering by a number of independent regions, each having its own drift speed and direction. These regions have drift velocities in excess of 1 km/s and horizontal dimensions often less than 30 km. (auth) (Canada)

45156 ELECTRIC FIELD EXCITATION OF $O_2(^1\Delta_g)$ IN AURORAS. Walker, James C. G. (Centre National d'Études des Telecommunications, Issy-les-Moulineaux, France). Planet. Space Sci.; 18: 1043-9(Jul 1970).

Two mechanisms are described by which auroral electric fields might excite the very large intensities of the infrared oxygen band observed by Noxon (1970). The first mechanism calls on electric fields perpendicular to the geomagnetic field to raise the temperature of ionospheric O_2^+ ions. The hot ions then exchange a charge with an ambient oxygen molecule and are left in the excited state, $O_2(^1\Delta_g)$. The second proposed mechanism invokes field-aligned currents associated with horizontal gradients in E-region electrical conductivity. These currents heat the ambient electrons, which become highly non-Maxwellian, and the electrons excite $O_2(^1\Delta_g)$ in collisions with ambient oxygen molecules. Both mechanisms can explain the observed auroral intensities of the infrared emission, but only if the most favorable assumptions are made

concerning the unknown cross sections for the two excitation processes. (auth) (UK)

45157 ABSORPTION INCREASES AT THE AURORAL ZONE CONJUGATE AREAS DURING GEOMAGNETICALLY DISTURBED PERIODS. Hajkowicz, L. A. (Melbourne Univ.). Planet. Space Sci.; 18: 1005-9(Jul 1970).

Comparison of the yearly (1966) 30 MHz riometer data for two auroral zone conjugate stations (L-value ≈ 5): Macquarie Island (South) and Kotzebue (North), indicates distinct diurnal distributions of cosmic noise absorption during geomagnetically disturbed periods. A small absorption maximum, for both stations, around the late morning and noon periods, is followed by an absorption decrease in the late afternoon and evening periods. This is followed by gradual absorption increases towards the morning hours. The absorptions increase rapidly during more disturbed periods, at ΣK_p over about 20. (auth) (UK)

45158 SEMIANNUAL VARIATION OF THE UPPER ATMOSPHERE. Bhatnagar, V. P. (Univ., Bonn). Planet. Space Sci.; 18: 1051-64(Jul 1970).

The effects of the seasonal variations of the dynamical properties of the lower thermosphere at and below 120 km, like the dissociation of molecular oxygen, the turbopause levels of different constituents, and the temperature on the semiannual variation (SAV) in the upper atmosphere on the basis of steady state models were studied. It is concluded that the seasonal variations in the mass density and temperature in the lower thermosphere as adopted from the US Standard Atmosphere Supplements (1966) in conjunction with the observed dissociation ratio (O/O_2) do not yield the observed semiannual amplitude (SAA) (maximum value in equinoctial months/minimum value in solstitial months) in the upper atmosphere. However, if one adopts on the basis of observations a SAA of about 1.25 in density and temperature in the lower thermosphere, the observed SAA at 190 km can be theoretically reproduced, but only if the ratio (O/O_2 in solstitial months/O/O_2 in equinoctial months) has a value of about 4 or if the number density of atomic oxygen in solstitial months is greater by a factor of about 1.7 than that in equinoctial months, at 120 km. Under the ideal condition of no seasonal variation in the lower thermospheric temperature, the observed SAA at 190 km can be theoretically reproduced if the above said ratio of 4 is reduced to 0.8. It is concluded that the SAV of the dissociation ratio at 120 km exists in phase or out of phase with that of the atmospheric density depending on whether the SAA in the temperature is less or greater than about 1.1 at 120 km. The increase of the SAA within the solar cycle, when the solar activity changes from 80 to 150 $\bar{F}$-units can be explained if the dissociation increases more rapidly with solar activity in equinoctial months as compared to that in solstitial months. At altitudes where helium predominates, the observed SAA indicates that the turbopause levels of helium lie at about 100 km in winter, 102 km in equinox, and 104 km in summer. (auth) (UK)

45159 GROUND-BASED PHOTOMETRIC OBSERVATIONS OF THE 1.27-mu BAND OF O_2 IN THE TWILIGHT AIRGLOW. Evans, W. F. J.; Wood, H. C.; Llewellyn, E. J. (Univ. of Saskatchewan, Saskatoon). Planet. Space Sci.; 18: 1065-73 (Jul 1970).

A two-channel photometric technique which permits accurate ground-based observations of the 1.27-μ band in the evening twilight is described. Several twilight observations are presented and compared with other available observations of the temporal variation of $O_2(^1\Delta_g)$ in the evening twilight. The application of this technique to ground-based observations of aurora is illustrated. (auth) (UK)

45160 NIGHT AIRGLOW HYDROXYL ROTATIONAL TEMPERATURES. Harrison, A. W. (Univ. of Calgary, Alberta); Llewellyn, E. J.; Nicholls, D. C. Can. J. Phys.; 48: 1766-8 (1 Aug 1970).

Rotational temperatures have been determined from observations of the OH emission in the night airglow. It is proposed that an apparent increase in the derived rotational temperature with the value of K' may be explained in terms of a nonisothermal emitting region. (auth)

45161 CONSISTENCY OF THE LIWSHITZ–SINGER MODEL OF THE EARTH'S HYDROGEN GEOCORONA WITH DATA OBTAINED FROM A SOLAR HYDROGEN LYMAN ALPHA ROCKET SPECTROGRAPH. Jones, Robert Archbold. Boulder, Colo.; Univ. of Colorado (1969). 204p. University Microfilms Order No. 70-5862.

Thesis.

The model of the Earth's hydrogen atmosphere by Liwshitz and Singer appears to give good representation of the physical situation. According to the model, the rapid escape of fast hydrogen atoms causes a reduced escape flux (as compared to Jeans' formula) and a cooling effect at the base of the exosphere. The hydrogen density is thus enhanced by the reduced loss rate, and the cooling causes a steeper gradient of the hydrogen density in the exosphere. The Liwshitz–Singer model is compared with data obtained from a hydrogen Lyman-alpha rocket spectrograph. The model predicts numerical values for the vertical distribution of atomic hydrogen for various temperatures. Using these numerical values of temperature and density in conjunction with the theory of Doppler and natural line broadening, the width and depth of the terrestrial contribution to the central absorption core of the hydrogen Lyman-alpha line profile may be determined. For a given altitude, the predicted profile is compared with the observed profile, in order to fit the model to the data. In particular, both temperature and an instrument line-broadening correction factor are varied as parameters, until the best fit is obtained. The new values of these parameters are the temperature of hydrogen in the Earth's atmosphere and the instrument correction factor, which are to be applied to the predicted line profiles for other altitudes. The Liwshitz–Singer model is found to be in close agreement with the data. (TSS) (Diss. Abstr. Int., B)

45162 ACOUSTIC–GRAVITY WAVES IN THE IONOSPHERE AND THEIR EFFECTS ON HIGH FREQUENCY RADIO PROPAGATION. Chang, Norman Jun Fai. Boulder, Colo.; Univ. of Colorado (1969). 264p. University Microfilms Order No. 70-5828.

Thesis.

The propagation of acoustic–gravity waves in the 1962 U. S. Standard Atmosphere is investigated. The calculations include the effects on the ionized atmosphere caused by the passage of these waves in the presence of viscosity and thermal conduction. These atmospheric wave effects are detected by the frequency fluctuations that they produce in ionospheric radio echoes on high frequencies. Frequency records are used to illustrate the theory developed. (TSS) (Diss. Abstr. Int., B)

45163 ATMOSPHERIC EMISSIONS. Proceedings of the NATO Advanced Study Institute Held at As, Norway, July 29-August 9, 1968. McCormac, Billy M.; Omholt, Anders (eds.). New York; Van Nostrand Reinhold Company, 1969. 573p. $25.95. (CONF-680720).

This book is based on the proceedings of the NATO Advanced Study Institute on the subject Aurora and Airglow. Each chapter was written by a ranking international authority, with more than ten chapters devoted to each of the main subject areas: auroral observation, fundamental sources of aurora and airglow observation and interpretations. (W.D.M.)

45164 SOME MECHANICAL ANALOGIES OF MAGNETODYNAMIC OSCILLATIONS IN A HOMOGENEOUS MEDIUM. Prikner, Karel (Geophysical Inst., Prague). Stud. Geophys. Geod.; 14: 339-44(1970).

Mechanical analogies are considered for Alfven-type magnetohydrodynamic waves and for the impact of a material body (solar-wind front) on a homogeneous density column (homogeneous MLF column) with a unit cross section and length l. (M.O.W.)

45165 AURORAL PHYSICS. Chapman, Sydney (High Altitude Observatory, Boulder, Colo.). Annu. Rev. Astron. Astrophys.; 8: 61-86(1970).

Topics covered include: auroral relations with geomagnetism and sunspots, the auroral spectrum, auroral morphology, particles that cause the aurorae, and events preceding the entry of auroral particles. (147 references) (W.D.M.)

45166 IONOSPHERIC WIND DYNAMO. Tarpley, Jerald Dan Jr. Boulder, Colo.; Univ. of Colorado (1969). 183p. University Microfilms Order No. 70-5897.

Thesis.

Electric currents and fields produced in the ionosphere by height-varying horizontal winds were investigated. The partial differential equation (called the dynamo equation) that describes the response of the ionosphere to a wind-induced emf is derived and the appropriate boundary conditions are discussed. The solutions of the dynamo equation under certain special conditions are described and a numerical method is presented by which the dynamo equation can be solved in the general case. A detailed conductivity model is calculated for the 90 to 150-km region of the ionosphere. The conductivity model contains the local time, latitude, and height variations of the ionospheric conductivity. Solution of the dynamo equation requires mathematical models of E-region wind fields. The relevant parts of tidal theory are discussed and some direct observations of E-region winds are reviewed with the goal of constructing such models. The wind systems of particular interest are the solar diurnal and semidiurnal tides and the

lunar semidiurnal tide. The dynamo equation is solved with several different model lunar tides and the resulting current patterns are compared with L current patterns deduced from geomagnetic observations. The best agreement between computed and observed lunar current patterns is produced by the lunar (2,2) mode with a maximum amplitude of 7.5 m/sec and a vertical wavelength of 85 km. The F2-region electrostatic drifts associated with this model tide are consistent with observed lunar oscillations in the height of the F2 region. The electric currents generated by the solar diurnal (1,3), (1,–1), and (1,–3) modes, the solar semidiurnal (2,2) and 2,4) modes, and certain nonperiodic winds are also calculated. The currents generated by the solar (1,–1) mode are found to be quite similar to observationally deduced Sq current systems. (Diss. Abstr. Int., B)

Low-Temperature Physics

Refer also to abstracts 44162, 44364, 44375, 44654, 44691, 44868, 44983, 45280, and 45356.

45167 (NYO–2391-116) MAGNETIC FIELD INDEPENDENT THERMOMETER FROM 0.1°K TO 10°K. Report No. 1404. Fiory, A. T. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Jul 1970. 13p. Dep. CFSTI.

Potassium chloride crystals doped with OH^- or CN^- ions are shown to be excellent magnetic field independent thermometers between 0.1 and 10°K. A procedure for making rugged capacitance thermometers, their sensitivity to temperature and their independence of magnetic field are discussed. (auth)

45168 (ORNL–4545, pp 147-67) MAGNETICS AND SUPERCONDUCTIVITY. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

MAGNET COILS — development of superconducting, for IMP facility

MAGNETIC MIRROR MACHINES — magnet development for IMP, superconducting

NIOBIUM ALLOYS & SYSTEMS — Nb–Ti, superconducting properties of compound conductors with twisted filaments

SUPERCONDUCTORS — thermal equilibrium of wires in flux-flow state

— properties of niobium–titanium with twisted filaments

TITANIUM ALLOYS & SYSTEMS — Nb–Ti, superconducting properties of compound conductors with twisted filaments (M.O.W.)

45169 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON ORGANIC SUPERCONDUCTORS, HELD AT HONOLULU, HAWAII, SEPTEMBER 5–9, 1969. Little, William A. (ed.). J. Polym. Sci., Part C; No. 29, 1-224(1970). (CONF-690960).

The following papers are included: a short history of superconductivity, high-temperature superconductivity, the exciton mechanism in superconductivity, the exciton mechanism — studies in model compounds, synthesis of conjugated schiff-base polymers, molecular packing in organic crystals, electron delocalization in anion radicals of permethylcyclopolysilanes, solid-state possibilities of porphyrin structures, exciton interaction between cyanine dyes and porphyrin, superconductivity in one and two dimensions, applications of many-body methods to large molecules, instabilities in theoretical chemistry, the challenge of superconductivity to organic chemistry, semiconducting polymers, specificity of the structure and properties of polyconjugated systems, an approach to biosynthesis of organic superconductors, the instabilities of the Hartree–Fock solutions for cyclic polyenes with respect to the spin and charge density fluctuations, inelastic electron scattering from organic compounds, and the possibility of superconductive-type enhanced conductivity in DNA at room temperature. (M.H.R.)

45170 HIGHER ORDER KINETIC THEORY OF EXCITATIONS IN He II AND SPONTANEOUS INSTABILITY IN A COUNTER CURRENT. Goodman, S. E.; Saffman, P. G. (California Inst. of Tech., Pasadena). Ann. Phys. (N. Y.); 59: 1-18(Jul 1970).

The kinetic theory of excitations in flowing liquid He II is developed to a higher order than that carried out previously in order to demonstrate the existence of nonequilibrium terms of a new nature in the hydrodynamic equations. It is shown that these terms can lead to spontaneous destabilization in counter currents when the relative velocity of the normal and super fluids exceeds a critical value depending on temperature. The critical velocities are estimated to range from 14 to 20 m/sec, but tend to zero as $T \to T_\lambda$. (auth)

45171 FEATURES OF ELECTRON DRAG OF DISLOCATIONS IN SUPERCONDUCTORS. Kaganov, M. I.; Natsik, V. D. (Physical-Technical Inst. of Low Temperature, Kharkov. Physical-Technical Inst., Kharkov). JETP Lett. (USSR) (Engl. Transl.); 11: 379-82(5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 550-3 (5 Jun 1970).

Results of an investigation of the force of the electron drag by dislocations in superconductors are presented. It is shown that when the metal goes over from the normal to the superconducting state this force has a complicated dependence on the velocity and on the temperature. (M.H.R.)

45172 CONTRIBUTION TO THE THEORY OF THE MIXED STATE OF TYPE-II SUPERCONDUCTORS. Bat'ev, E. G. (Inst. of Semiconductor Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 11: 382-5(5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 554-6 (5 Jun 1970).

A method is proposed for describing a superconductor in the case when the Cooper pairs can form several condensates, i.e., they can accumulate in several different states. This problem is meaningful in the presence of degeneracy of the ground state of the Cooper pair, as is the case in a Type-II superconductor in a magnetic field. The starting point is the Ginzburg–Landau theory. (M.H.R.)

45173 UPPER CRITICAL FIELD OF HIGH SUPERCONDUCTING TRANSITION TEMPERATURE $Nb_3Al_{0.75}Ge_{0.25}$ ALLOY AT 4.2°K. Yasukochi, Ko; Akihama, Ryozo; Usui, Nobumitsu (Nihon Univ., Tokyo). Jap. J. Appl. Phys.; 9: 845(Jul 1970).

Using a pulsive magnet, H_{c_2} for $Nb_3Al_{0.75}Ge_{0.25}$ was found to be 420 kG. (M.H.R.)

45174 ENERGY SPECTRUM OF THE EXCITATIONS IN LIQUID HELIUM II. Sunakawa, Sigenobu; Yamasaki, Shuichiro; Kebukawa, Takeji (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 41: 919-40(Apr 1969).

The excitation energy in liquid helium II is studied from first principles. On the basis of the formalism developed in previous papers, the contribution from the phonon–phonon interactions is taken into consideration. The calculation of the excitation energy is carried out by making use of a slightly different method from that of the standard perturbation theory. The result is compared with the experimentally measured excitation spectrum, and we have obtained a surprisingly good agreement with experiment. (auth)

45175 MOTION OF THE VORTEX LATTICE IN A PURE TYPE II SUPERCONDUCTOR. Maki, Kazumi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 41: 902-18(Apr 1969).

Various transport currents in the resistive state of a pure type-II superconductor in high magnetic fields are reexamined microscopically. It is found that some important terms in the current expressions were neglected in the earlier version by Caroli and Maki. The inclusion of these terms results in the following expressions of the flow resistivity R_f and the Hall angle ϕ. $R_f = R_n\{1-[m(H_{c_2} - B)/(\pi eN(1.16(2\kappa_1^2(t) - 1) + 1)]\}$ and $\phi = \tau eB/m$, where B is the magnetic induction. The Ettingshausen coefficient and the Peltier coefficient are also derived. (auth)

45176 ENERGY FLUX BETWEEN TWO SUPERFLUID HELIUM BATHS SEPARATED BY A THIN LAYER. Seiden, Joseph (Paris Univ.). Compt. Rend., Ser. B; 271: 5-8(6 Jul 1970). (In French).

The radiative equilibrium of a thin layer separating two superfluid helium baths maintained at a temperature difference is investigated. Statistical and geometrical calculations of the energy flux between the two baths are made. The flux is identical for an insulation and a metal, and is determined from the Kapitza resistance of the layer. The expression obtained is not always in good agreement with some of the experimental results. (tr-auth) (France)

45177 GENERALIZED DIFFUSION EQUATION FOR SUPERCONDUCTING ALLOYS. Usadel, Klaus D. (Univ. of Montreal). Phys. Rev. Lett.; 25: 507-9(24 Aug 1970).

Eilenberger's transport-like equations for a type-II superconductor can be simplified very much in the dirty limit. In this limit a diffusionlike equation is derived that is the generalization of the de Gennes–Maki theory for dirty superconductors to arbitrary values of the order parameter. (auth)

45178 DEFORMATION-INDUCED ANISOTROPY OF THE CRITICAL CURRENT IN SINGLE CRYSTAL NIOBIUM. Good, Jeremy A. (Oxford Univ.); Kramer, Edward J. Phil. Mag.; 22: 329-58(Aug 1970).

Anisotropy of the critical current in a [110] niobium single crystal of very high purity is observed to result from tensile deforma-

tion. The critical current exhibits local maxima when the magnetic field is directed along the [1$\bar{1}$0] and [001] directions. The height of the [1$\bar{1}$0] maximum increases with respect to the height of the [001] maximum as the magnetic field is decreased. The [001] maximum is sensitive to the condition of the sample surface and exhibits rectification. The anisotropy is not caused by the anisotropy in H_{c2}, by sub-oxide or other precipitates or by the ellipticity of the deformed crystal surface. There is a contribution to the anisotropy of the as-deformed crystal caused by anisotropic surface roughness, which can be removed by chemical polishing. The [1$\bar{1}$0] maximum is attributed to the interactions between flux lines and parallel dislocation debris in the interior of the crystal, the dislocation lines lying primarily along the [1$\bar{1}$0] direction. The pinning force, estimated on the basis of the Yamafuji–Irie theory (1967), agrees within an order of magnitude with the theoretical estimates of the elastic interaction force between a dislocation and a parallel flux line. The [001] maximum is tentatively assigned to the interaction between dislocations and flux lines near the crystal surface, the density of dislocations threading the (1$\bar{1}$0) surface being higher than that threading the (001) surface. The effect of the interaction at the surface is thought to be magnified by the decrease in the flux line lattice shear modulus C_{66} in that region. (auth) (UK)

45179 APPROXIMATE CALCULATION OF THE REVERSIBLE MAGNETIZATION CURVE OF TYPE II SUPERCONDUCTORS. Koppe, H.; Willebrand, J. (Univ., Kiel). J. Low Temp. Phys.; 2: 499-506(Jun 1970).

The Ginsburg–Landau equations are solved approximately by a variational principle. The reversible magnetization curve is calculated and found to be in good agreement with exact results of the GL theory. (auth)

45180 IMPURITIES WITH INTERNAL DEGREES OF FREEDOM IN SUPERCONDUCTORS. Brandt, U. (Univ., Hamburg). J. Low Temp. Phys.; 2: 573-86(Jun 1970).

The properties of an electron gas interacting with a system of nonmagnetic impurities having internal degrees of freedom that allow the electrons to be scattered inelastically are investigated. The modifications of Green's functions in the normal and superconducting state due to this inelastic scattering are determined, and the changes of the superconducting transition temperature, the order parameter, and the density of states are calculated. In this model the transition temperature and the order parameter are shown to increase, and the density of states is shown to change its functional behavior drastically. The elastic part of the scattering affects neither the transition temperature, nor the order parameter, nor the density of states. (auth)

45181 MODEL STUDY OF THE PRESSURE VARIATION OF THE SUPERCONDUCTING TRANSITION TEMPERATURE. Sikora, P. T. (Atomic Energy Research Establishment, Harwell, Eng.). J. Low Temp. Phys.; 2: 587-97(Jun 1970).

The volume dependence of the Morel–Anderson prescription for the superconducting transition temperature is calculated. The resulting expressions depend only upon atomic constants, the specific-heat effective mass, and the Grueneisen constant. No undetermined parameters enter. On the basis of the model, the full range of observed pressure dependences of T_c can be qualitatively understood. Quantitative comparison with experiment is made and is generally satisfactory, but a lack of reliable data prevents definitive assessment of the general applicability of the model. (auth)

45182 PARAFLUIDITY IN HELIUM NEAR THE λ TRANSITION AND THE GENERALIZED TIME-DEPENDENT LANDAU THEORY. Stauffer, D. (Technische Hochschule, Munich); Wong, Victor K. J. Low Temp. Phys.; 2: 599-617(Jun 1970).

A phenomenological theory of parafluidity, i.e., an enhancement of fluidity due to order-parameter fluctuations, is presented for helium near the λ transition. The generalized time-dependent Landau theory of second-order phase transitions is reviewed in general and is applied to the superfluid transition in helium as a particular example. In helium, it is found that parafluidity is manifested in the divergences of the mass diffusivity $D_m \propto \epsilon^{-\gamma}$, the thermal conductivity $\kappa \propto \epsilon^{-\gamma}$, the first-sound amplitude attenuation $\alpha \propto |\epsilon|^{-1}$, and the second-sound damping $D_2 \propto (-\epsilon)^{-\gamma}$, which are all consistent with the dynamic-scaling hypothesis. Here a characteristic relaxation time $\tau_0 \propto |\epsilon|^{-1}$ is used, where $\epsilon = (T - T_c)/T_c$ and T_c is the transition temperature. Although there are not enough experimental data to confirm the formulas, the present approach is seen to agree in order of magnitude with available experiments. Finally, the sound absorption above a ferromagnetic transition is calculated by adding a diffusion term to the generalized time-dependent Landau equation. The result thus obtained agrees in order of magnitude with experiments in nickel. (auth)

45183 SUPERCONDUCTIVITY IN THIN SEMICONDUCTING AND SEMIMETALLIC FILMS. Borisyuk, V. A. (Inst. of Physics, Krasnoyarsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 376-7(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 484-6(Feb 1970).

It is shown that the Coulomb repulsion between particles can be reduced (thereby increasing the superconducting transition temperature) by using a substrate with a large dielectric permeability ϵ. It is also possible that superconducting films of nonsuperconducting semiconductors can be obtained in a similar way. (auth)

45184 INVESTIGATION OF LONGITUDINAL CRITICAL CURRENTS IN SUPERCONDUCTING ALLOYS WITH Ti AND Zr AS THE BASE METALS. Karasik, V. R.; Vereshchagin, V. G. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 36-47(Jul 1970). (In Russian).

Longitudinal critical currents in wire and ribbon samples prepared from the alloys Ti–22 at. % Nb and Zr–20 at. % Nb, 65 BT were investigated. It was found that the magnitude of the maximal current is not determined by the nature of the structural defects but by the parameter H/λ. A study was made of the anisotropy of the critical current with respect to the angle between the wire axis and the external magnetic field for various mechanisms of destruction of superconductivity by the current. A condition for obtaining highest attainable currents in superconducting alloys is formulated. (auth)

45185 SUPERCONDUCTIVITY OF LAMELLAR STRUCTURES. INVESTIGATION OF SOLID SOLUTIONS IN THE $NbSe_2$–$NbTe_2$ SYSTEM. Antonova, E. A.; Kiseleva, K. V.; Medvedev, S. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 54-8(Jul 1970). (In Russian).

The crystal structure and superconducting properties of single crystals of $NbSe_2$–$NbTe_2$ solid solutions with a lamellar structure were investigated. From the results obtained it is concluded that the superconducting properties of lamellar compounds of transition metal dichalcogenides not only depend on the state of the niobium planes but also on the degree of correlation between them. (auth)

45186 INVESTIGATION OF THE TUNNELLING EFFECT IN LEAD AND THALLIUM UNDER PRESSURE. Galkin, A. A.; Svistunov, V. M.; Dikii, A. P.; Taranenko, V. N. (Donetsk Physical-Technical Inst., Kiev). Zh. Eksp. Teor. Fiz.; 59: 77-87(Jul 1970). (In Russian).

The applicability of the tunnel effect to investigations of superconductivity under pressure is discussed. Experimental results are presented on a study of lead and thallium films involving superconductor–barrier–superconductor (S–I–S) tunnel systems at pressures up to 14 kbars. Data are presented on the energy gap and characteristic frequencies of the phonon spectrum. Thick ($d > \xi_0$) films exhibiting gap anisotropy are investigated in the case of lead. It was found that under pressure the gap anisotropy does not change significantly. (auth)

45187 PROPERTIES OF THIN SUPERCONDUCTING FILMS IN HIGH FREQUENCY FIELDS. Ovchinnikov, Yu. N. (Landau Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 128-41(Jul 1970). (In Russian).

In thin superconducting films ($d \ll \xi$) the linear response to a weak rapidly varying field is found for an arbitrary static magnetic field and current. The dependence of the critical current on magnetic field strength is also obtained. The results are valid for a mean free path $l \ll (\xi d)^{1/2}$. (auth)

45188 NONLINEAR ELECTRODYNAMICS OF THIN SUPERCONDUCTING FILMS. Gor'kov, L. P.; Kopnin, N. B. (Landau Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 234-45(Jul 1970). (In Russian).

The nonlinear electrodynamics of a thin superconducting film located in a stationary magnetic field close to the critical value is considered. At temperatures close to T_c, anomalous terms in the equations for superconductors become important. A very pronounced nonadiabatic pattern of dependence of the gap Δ on field strength is observed in this case throughout the entire frequency range under consideration ($1/\tau_\epsilon \ll \omega \ll \Delta_0$). This circumstance permits one to derive the quantitative dependence of the penetration factor D on the uhf power. The hysteresis nature of the dependence of D on uhf power that arises in this case is considered. Current states of the film are also briefly investigated. (auth)

45189 RESONANCE AND OSCILLATORY EFFECTS IN SUPERCONDUCTORS. Azbel, M. Ya. (Landau Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 295-313(Jul 1970). (In Russian).

A phenomenological theory of superconductivity is developed. It is shown that single-particle excitations in superconductors are quasi particles with dispersion rules; the quasi particles move along the phase trajectories shown. The motion of the quasi particles is quantized. This results in a very complex energy spectrum that is characterized by discrete branches being detached periodically from the continuous spectrum. One case is quasi-classical and the quantization conditions are of the Bohr type; qualitatively, they correspond to equidistant changes of the momentum in a classical orbit. The quasi-classical superconductivity equation is derived; it is valid in the London case at high-enough magnetic fields when the temperature is not very near the critical one. The periodic nature of variation of the spectrum results in quantum oscillations of thermodynamic and kinetic quantities with a relative amplitude (analogs of the de Haas–van Alphen and Shubnikov–de Haas etc. effects). Discreteness of the levels results in resonances (electromagnetic and ultrasound) with a relative amplitude of resonance variation Z′(H) (Z is the impedance and H external stationary magnetic field); the discreteness is also the cause of undamped waves and of the proper oscillations in the superconductors. (auth)

45190 CREEP OF SOME METALS AT THE SUPERCONDUCTING TRANSITION. Soldatov, V. P.; Startsev, V. I.; Vainblat, T. I. (Physical-Technical Inst. of Low Temperatures, Kharkov). J. Low Temp. Phys.; 2: 641-52(Jun 1970).

The influence of the superconducting transition on the creep of lead, indium, tin, and thallium was studied. It is shown that the transition to the superconducting state was accompanied by the jump-like creep-rate increase (sharp jump of the deformation creep curve). The jump of the deformation creep curve is indirectly dependent on the stress at which the metal transition from the normal (N) into the superconducting (S) state occurs and is observed when reaching some threshold value of the flow stress which differs for various metals. The regularities of the above phenomenon were investigated at transient and constant-strain creep rate. The time law of the creep in the N and S states and the character of the temperature dependence of the observed effect were determined. It is demonstrated that previously known experimental data and those described in the present paper can be explained without contradiction if they are interpreted in terms of the dynamic drag of dislocations, from the viewpoint of the disappearance of the force of their interaction with the conduction electrons during the N → S transition, as well as the increase of the number of movable dislocations in the course of this transition. (auth)

45191 INTERFACIAL TENSION IN A PHASE-SEPARATED ^{3}He–^{4}He MIXTURE. Dickson, D. P. E.; Caroline, D.; Mendoza, E. (University Coll. of North Wales, Bangor). Phys. Lett., 32A: 419-20(24 Aug 1970).

The interfacial tension in a phase-separated ^{3}He–^{4}He mixture was determined between 0.33 and 0.68°K. Results are consistent with Brouwer and Pathria's estimate of 0.10 erg/cm^2 for the interfacial tension at absolute zero. (auth)

45192 SUPERCONDUCTIVE TUNNELING JUNCTIONS AS DETECTOR OF THERMAL GENERATED PULSES OF THz PHONONS. Schulz, J. P.; Weis, O. (Univ., Heidelberg). Phys. Lett., 32A: 381-2(24 Aug 1970).

Experiments are reported on the detection of broadband phonon radiation with center frequencies in the THz range using superconductive tunneling junctions. The results show that superconductive tunneling junctions are suitable detectors of phonons with frequencies above the gap frequency. (auth)

45193 SPECIFIC HEAT AND SUPERCONDUCTIVITY OF BINARY ALLOYS CONTAINING V, Nb, AND Ta. Corsan, J. M.; Cook, A. J. (National Physical Lab., Teddington, Eng.). Phys. Status Solidi; 40: 657-65(1 Aug 1970).

The electronic specific heat coefficient, γ, the Debye temperature, θ_D, and the superconducting transition temperature, T_c, were measured for binary bcc alloys of V, Nb, and Ta. These results were used to investigate the effects of compositional changes on parameters used in the theory of superconductivity to describe the transition temperature. It has been shown that changes in transition temperature with changes in composition cannot be explained simply on the basis of an alteration of the density of states except in the case of binary Nb–Ta alloys. It is concluded that, for V–Nb and V–Ta alloys, changes in the interaction responsible for superconductivity also govern changes in the transition temperature. (auth)

45194 STRUCTURAL EFFECTS ON SUPERCONDUCTING THIN FILMS OF NIOBIUM. Connella III, Michael. New Orleans; Tulane Univ. (1969). 109p. University Microfilms Order No. 70-6388. Thesis.

This study was undertaken to find some correlation between structural modifications and superconducting properties of thin niobium films. Films were prepared in ultrahigh vacuum by electron beam evaporation on polished MgO substrates. Films were examined by electron-microscopy techniques. Initiating structures were observed to be "mixed" structures of NbO, fcc Nb, and bcc Nb with low deposition rates the controlling factor. The predominant epitaxial growth pattern was (001) bcc Nb||(001) MgO. As films deviated from the single crystalline structure, the resistivity values increased until the highest value obtained was for the "mixed" fcc and bcc structure. Resistivities were generally in agreement with the amount of "variation in structure." Superconducting electrical properties were observed for $H > H_{c_2}$ where surface superconductivity exists. Critical field values were measured for the film surface parallel (J||H) and perpendicular (J ⊥ H) to the applied magnetic field. These values were much higher for the films in the perpendicular orientation. Critical fields were found to vary linearly with resistivity for low-resistivity values. Films were found to have increased critical fields for the same resistivity values as corresponding bulk samples. Critical field enhancement could be attributed to the initiating structures and to small grain sizes. For films examined, H_{c_2} appeared to vary exponentially with 1/l. Correlations between film structure and superconducting properties could be crudely explained in terms of mean free path effects. (Diss. Abstr. Int., B)

45195 MOVIE FILMS OF CAVITATION IN SUPERFLUID HELIUM. Mosse, A.; Chu, M. L. Jr.; Finch, R. D. (Univ. of Houston, Tex.). J. Acoust. Soc. Amer.; 47: 1258-61(May 1970).

Movie films of cavitation in helium II show that bubbles occur in the form of streamers that can persist for hundreds of sound cycles. The streamers are frequently paired, apparently having a common point of origin. The threshold for visible events shows hysteresis, in that different values are obtained for incipient and desinent cavitation. The significance of the observations is discussed. (auth)

45196 JOSEPHSON EFFECT AND e/h. Clarke, John (Univ. of California, Berkeley). Amer. J. Phys.; 38: 1071-95 (Sep 1970).

A Josephson junction, consisting of two superconductors weakly coupled together, is an example of a very simple macroscopic quantum system. When there is a voltage V across the junction, the supercurrents flowing through it oscillate at a frequency given very precisely by the relation $\nu = 2eV/h$. The general validity of this formula has been used recently by Parker, Langenberg, Denenstein, and Taylor as the basis for a new determination of the fundamental constant ratio e/h. The new value is 38 ± 10 ppm smaller than the previously accepted value. This result has far-reaching implications concerning the values of the fundamental constants and quantum electrodynamics. A simple derivation of the Josephson voltage–frequency relation is given. Theory suggests that there should be no significant corrections to this equation, a result which is well confirmed by experiment. Various types of junctions are then described, together with their applications to the measurement of e/h. The impact of this measurement upon the fundamental constants and quantum electrodynamics is briefly discussed. It seems likely that Josephson junctions will have an important application in comparing and maintaining standards of electromotive force. (auth)

45197 THIN-FILM SUPERCONDUCTORS AS SENSITIVE THERMOMETERS. Liebenberg, D. H.; Allen, L. D. F. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys.; 41: 4050-4 (Sep 1970).

Thin films of granular aluminum operated in the resistive transition region to the superconducting state were used to measure temperatures to an accuracy of ±3 m°K and to a sensitivity of better than 10^{-5}°K. The stability of the film was determined and the film was calibrated on the 1958 T scale. A film of "staircase" construction was used to extend the temperature range of these films without loss of sensitivity. (auth)

45198 FLUX INSTABILITIES IN HIGH FIELD SUPERCONDUCTING WIRES. Kobayashi, Hisayasu; Yasukochi, Ko; Ogasawara, Takeshi (Nihon Univ., Tokyo). Jap. J. Appl. Phys.; 9: 889-903(Aug 1970).

The magnetic flux instability in Nb–25% Zr wires 0.25 mm in diameter was investigated, and the low-field instability is found to be an intrinsic phenomenon of high-field superconducting wires. The flux jump is induced artificially by an application of the heat pulse and the magnetic field pulse. The stability is represented quantitatively by a minimum power of the pulse P_c at which the superconductor quenches into a normal state. The critical power P_c reduces discontinuously above a certain current, the threshold

current I_t. Threshold current I_t and P_c depend on the history of the field-current application. The stability at the current above I_t increases with increasing ambient magnetic field and with decreasing critical current. Partial flux jump is induced above a certain current I_f below I_t. The detailed structure of the distribution of the magnetic induction in the sample plays an important role in the stability. (auth)

45199 LOW-TEMPERATURE SPECIFIC HEATS OF DILUTE PbTl AND PbBi ALLOYS. Clune, Lavern Charles. Cleveland; Case Western Reserve Univ. (1968). 112p. University Microfilms Order No. 70-5009.

Thesis.

The specific heats of pure lead and dilute PbTl and PbBi alloys, in both the normal and superconducting state, have been measured in the temperature range 1.0 to 2.3 K. The solute concentrations were 4.6% and 9.8% Tl and 4.6% and 8.9% Bi. All measurements were made in a helium-3 calorimeter designed for this purpose, and normal state measurements were made by surrounding the sample with a superconducting solenoid and applying a magnetic field of 10 kilogauss. Two significant experimental parameters are obtained from the normal state data — the electronic specific heat coefficient, γ, and the Debye temperature, θ_D. The changes in γ upon alloying have been the primary interest, and for both alloy series γ was found to be an increasing function of e/a. For PbTl alloys the fractional rate of change with e/a is $d(\ln \gamma)/d(e/a) = 0.3$ while for PbBi alloys $d(\ln \gamma)/d(e/a) = 0.6$. (TSS) (Diss. Abstr. Int., B)

45200 RESOURCE LETTER SCY-2 ON SUPERCONDUCTIVITY. Ginsberg, D. M. (Univ. of Illinois, Urbana). Amer. J. Phys.; 38: 949-55(Aug 1970).

Some of the major areas of recent activity are indicated and a representative list of references for teaching purposes in those areas are given. These areas are the Ginzburg–Landau theory, Josephson effects, pair-breaking interactions, the structure and motion of quantized magnetic vortices, the superconducting surface sheath, strong-coupling superconductors, superconducting semiconductors, fluctuations, nuclear physics and astrophysics, and applications. Some general references and laboratory and demonstration experiments and a film are included. (M.H.R.)

45201 HEAT TRANSFER TO LIQUID HELIUM IN NARROW CHANNELS WITH LAMINAR AND TURBULENT FLOW. Jergel, M.; Stevenson, R. (McGill Univ., Montreal). Appl. Phys. Lett.; 17: 125-7(1 Aug 1970).

Boiling heat transfer of liquid helium at 4.2°K has been studied under conditions of forced flow through rectangular channels. The heat transfer characteristic is dependent on whether the flow is laminar or turbulent. Both types of flow give greatly increased heat transfer, turbulent flow being superior. A correlation of the heat transfer data was obtained. (auth)

45202 CURRENT NOISE IN JOSEPHSON POINT CONTACTS. Kanter, H.; Vernon, F. L. Jr. (Aerospace Corp., El Segundo, Calif.). Contract F 0470169-C-0066. Phys. Rev. Lett.; 25: 588-90(31 Aug 1970).

The dependence and magnitude of noise currents in superconducting point contacts on dc current and voltage have been measured. The results are in good agreement with the theoretical predictions of Scalapino and Stephen. As expected, in the shot-noise limit at sufficiently high junction voltage the noise current does not vary with temperature. (auth)

45203 VORTICITY IN HELIUM FILM CREEP. Takken, Edward H. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 25: 572-5(31 Aug 1970).

The viscous drag of the normal-fluid component on moving superfluid vortex-line cores is shown to have two effects: to push the vortex lines toward the film surface and to enhance the film-creep velocity. A class of experiments in the millidegree temperature range is proposed in order to test for the presence of vorticity in helium film creep. (auth)

45204 EFFECT OF PRESSURE ON SUPERCONDUCTING-STATE PARAMETERS AND TRANSITION TEMPERATURE OF SIMPLE METAL SUPERCONDUCTORS. Rajput, J. S. (Banaras Hindu Univ., India); Gupta, A. K. Phys. Status Solidi; 40: 87-92(1 Jul 1970).

A method is presented for the theoretical calculation of the logarithmic volume derivatives of the three superconducting state parameters: the phonon interaction parameter, the coulomb pseudopotential, and the energy renormalization parameter. The two representative cases of lead and aluminum were studied. The initial linear drop of T_c when plotted against change in volume, which is an experimentally observed fact, is theoretically confirmed. (auth)

45205 SUPRASTRICTION IN SUPERCONDUCTORS. Kronmueller, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi; 40: 295-308(1 Jul 1970).

By means of the micromagnetic equations of superconductivity, the deformation of a superconductor below the transition temperature is determined. It is shown that, as in ferromagnets, the deformation of a superconductor may be divided into spontaneous and forced suprastriction, and the form effect. The theoretical results are compared with recent experiments. (auth)

45206 TUNNELLING MEASUREMENTS ON SUPERCONDUCTING ALLOY FILMS IN A PERPENDICULAR FIELD. Ward, R.; Tilley, D. R. (Univ. of Essex, Colchester, Eng.). J. Phys., C (London); 3: 1718-26(Aug 1970).

Using the electron tunnelling technique, a study was made of superconducting alloy films of Sn–In in magnetic fields perpendicular to the surface. Measurements of the function $f(\eta)$ introduced by Maki (1965 and 1964) to take account of the decreased effects of screening currents for thin films were in good general agreement with theory. Measurements of the second generalized Ginzburg–Landau parameter were compared with the theoretical predictions of Eilenberger (1967). Some disparity was found between theory and experiment, the results being in general agreement with those of French and Lowell (1968) on bulk specimens of Nb–Mo alloys. (auth) (UK)

45207 STUDY OF THE QUENCHING PROPAGATION OF BARE AND INSULATED SEMISTABILIZED SUPERCONDUCTING WIRES. Shimamoto, S.; Desportes, H. (CEN de Saclay, Gif-sur-Yvette, France). J. Appl. Phys.; 41: 3286-94(Jul 1970).

The minimum propagating current, the velocity of propagation, and the temperature rise in semistabilized superconducting wires with and without insulation were measured by heat pulse tests in magnetic fields up to 70 kG. These experiments showed that insulated wire can be more stable under external heat perturbation than bare wire and that its temperature rise after quenching is slower. The tests also showed that the velocity of propagation is strongly affected, at any current level, by the cooling conditions and by even a very thin surface coating on the wire. (auth)

45208 INDUCTION PENETRATION, ELECTRIC FIELD, AND LOSSES IN TYPE II SUPERCONDUCTORS EXHIBITING SURFACE CURRENTS. Fournet, G.; Mailfert, A. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France). J. Phys. (Paris); 31: 357-67(Apr 1970). (In French).

The behavior of hard superconductors in ac magnetic fields was studied. The critical state model was used in its general form where the bulk critical current density j is any function of the magnetic induction B; a critical surface current was also considered. Rigorous expressions of the electric field at each point are given, and a method of measurement of the critical current densities for low magnetic field is deduced. The behavior of hard superconductors for several critical-state laws is calculated. The experiments performed with Nb/Zr (25% Zr) showed a good agreement with the theoretical results. The losses were calculated, and the rigorous theoretical relations obtained for some critical laws showed that several expressions given by other works are approximate. (tr-auth) (France)

45209 PROPAGATION OF A WAVE IN A SUPERCONDUCTING GUIDE USING THE NONLOCAL THEORY. Zepp, G. (Clermont-Ferrand Univ., France). J. Phys. (Paris); 31: 513-17(May–Jun 1970). (In French).

The propagation of a plane electromagnetic wave between two superconducting materials limited by plane parallel surfaces was studied. The coherence length ξ is supposed to be large; and it was necessary to use a nonlocal law not only for normal current densities but for superconducting current densities. The behavior of the electrons near the surfaces limiting the superconducting materials was taken into account. (tr-auth) (France)

45210 INVESTIGATION OF THE GINZBURG–LANDAU PARAMETER IN INDIUM ALLOYS. Fischer, Erich (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 42: 1003-21(30 Dec 1969). (In German).

To test the formulas proposed by Gorkov and Goodman, predicting an increase of the Ginzburg–Landau parameter κ with the residual resistance of the material, various indium alloys were studied. Despite addition of various distorting factors, no significant deviation from the Gorkov–Goodman formula was detected. On the alloy containing In–14% Tl, the temperature dependency of the Ginzburg–Landau parameter was measured. Experimental results confirmed the newest theoretical calculations. (tr-auth)

45211 BEHAVIOR OF TYPE-II SUPERCONDUCTORS UNDER PRESSURE. Fischer, Erich (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 42: 1022-38(30 Dec 1969). (In German).

The Ginzburg–Landau parameter $\varkappa$ was measured at pressures ranging from 1 to 15,000 atm in indium with 14 at. % thallium and with 5, 7, and 9 at. % of lead. In all four cases $\varkappa$ decreases with pressure. This decrease can be explained by the behavior of the residual resistance as well as by the temperature coefficient of the electronic specific heat. For the alloy system indium–lead, the pressure dependency of critical temperature was determined as function of concentration. Considerable disagreement was found between pressure results for T_c in pure indium. (tr-auth)

45212 QUANTIZATION OF CIRCULATION IN SUPERFLUID HELIUM. Garrison, John C. (Univ. of California, Livermore); Wong, Jack; Morrison, Harry L. Phys. Rev., A; 2: 491-4(Aug 1970).

It is shown that the quantization of circulation in superfluid helium can be understood in a fundamental way by an argument analogous to that used by Byers and Yang for flux quantization in superconductors. The ac Josephson effect in helium also follows simply from this argument. (auth)

45213 PHONON–PHONON INTERACTIONS IN LIQUID HELIUM II. Carroll, C. E. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 2: 497-518(Aug 1970).

The quantum hydrodynamics of Landau is here regarded as a means of calculating phonon–phonon interactions in liquid helium II. This theory is tested by applying it to the low-density Bose–Einstein gas; at low temperatures and long wavelengths, it agrees with the microscopic theory of the Bose–Einstein gas. This agreement justifies the past use of the hydrodynamic theory to calculate the Landau–Rumer sound absorption in liquid helium; however, the calculated absorption is roughly half that measured by Abraham, Eckstein, Ketterson, Kuchnir, and Vignos. Hence the higher-order terms in the hydrodynamic theory are considered; they probably cannot account for the discrepancy. (auth)

45214 ENGINEERING APPLICATIONS OF SUPERCONDUCTIVITY. Donaldson, G. W. (New South Wales Univ., Kensington, Australia). J. Inst. Eng., Aust.; 42: 78-82(Jun 1970).

A review is given of superconducting materials with reference to their engineering application to dc magnets, motors, exciters, alternators, transmission cables and transformers. Losses in superconductors, liquid helium techniques, and cost are also considered. (Australia)

Plasma and Thermonuclear Physics

45215 (ORNL–4545) THERMONUCLEAR DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1969. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 179p. Dep. CFSTI.

Separate abstracts were prepared for the 11 individual sections. (M.O.W.)

For abstracts of individual sections see: 44972, 45168, 45218–45220, 45264–45266, 45274, 45275, and 45291.

45216 PLASMA DYNAMICS. Boyd, T. J. M.; Sanderson, J. J. Applications of Mathematics Series. New York; Barnes and Noble, Inc. (1969). 454p. $10.75.

The following chapters are included: (1) particle orbit theory, (2) macroscopic equations, (3) hydromagnetics, (4) hydromagnetic flows, (5) shock waves in plasmas, (6) waves in cold plasma, (7) waves in warm plasmas, (8) plasma radiation, and (9) kinetic theory. (M.O.W.)

45217 PLASMA PHYSICS INDEX. VOLUME 5, NO. 7, 1970. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 133p.

This listing includes 641 articles on various aspects of plasma physics. (M.O.W.)

Confinement and Heating

Refer also to abstract 45265.

45218 (ORNL–4545, p 58) TOROIDAL CONFINEMENT. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

Very brief discussions of work on toroidal-confinement ORMAK and toroidal multipoles programs are given. (M.O.W.)

45219 (ORNL–4545, pp 59-71) HIGH-BETA PLASMA. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

Discussions of research are given for each of the following areas: (1) off-resonant heating in ELMO facility with $\omega > \omega_{ce}$, (2) driven losses with low-frequency microwave power, (3) instability studies, and (4) ion hybrid heating. (M.O.W.)

45220 (ORNL–4545, pp 72-103) TURBULENT HEATING. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

ELECTRON BEAMS—interactions with plasma, limitations on ion and electron heating in
MAGNETIC MIRROR MACHINES—plasma heating mechanisms in Burnout V
—plasma turbulence and diagnostics in Burnout V
PLASMA—electron beam interactions with, limitations on ion and electron heating in
—heating in beam–plasma system, limitations in
—heating by electron beams in Burnout V
—diagnostics in Burnout V facility
—turbulence in Burnout V facility (M.O.W.)

45221 LASER-DRIVEN AXIAL FLOW PINCH IN A DENSE PLASMA FOCUS. Guillaneux, P.; Patou, C.; Tonon, G. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Phys. Lett., 32A: 370-1(24 Aug 1970).

A description is given of a proposed experiment on the coupling of a laser-created plasma with the focus discharge, in order to set up a plasma flow during the focusing phase. (auth)

45222 STOCHASTIC KINETIC THEORY AND TURBULENT HEATING. Ogunlana, J. (Univ. of California, San Diego, La Jolla). Nuovo Cim.; 69B: 20-40(11 Sep 1970).

A stochastic-theory approach is used to formulate the problem of plasma heating by random fields. The method predicts the effect of arbitrary accelerating fields on the plasma, in contradistinction to previous works in which crucial assumptions render the works valid only for single-particle acceleration. Application of the theory to stochastic acceleration of a magnetized plasma yields a heating rate which asymptotically approaches that of Puri. Other applications to ionospheric phenomena and thermonuclear fusion are discussed. Finally, a new nonlinear method is presented for obtaining the single-particle distribution function. (auth)

Diagnostics

Refer also to abstract 45267.

45223 (NP–18372) POSSIBILITY OF MEASURING THE DIRECTED FLOW IN PLASMA CONFINED IN TOROIDAL MAGNETIC TRAPS. Preprint No. 62. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1970. 23p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A plane grid probe was used for measuring a complete flow in confined magnetic traps. Calculations utilizing the Bohm concept for resolving the current in the plane probe collector placed in a magnetized plasma are presented, and Galaktionov's corrective formulas that take the magnetic field into account are used. (R.V.J.)

45224 MEASUREMENT OF ELECTRON ENERGY DISTRIBUTIONS IN THE PRESENCE OF OSCILLATIONS. Gulidov, S. S.; Kagan, Yu. M.; Kolokolov, N. B.; Milenin, V. M. (Leningrad State Univ.). Zh. Tekh. Fiz., 39: 1321-2(July 1969). (In Russian).

Results of measurements of electron energy distribution made by means of "tracking" probe in an oscillating plasma are presented. (tr-auth)

45225 METHOD FOR PASSIVE CORPUSCULAR DIAGNOSTICS OF HIGH-TEMPERATURE PLASMA. Alinovskii, N. I.; Altyntsev, A. T.; Koshilev, N. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 132-7(May–Jun 1970). (In Russian).

Diagnostic apparatus, results of calibration, and methods of developing experimental data are discussed. The calibration of the stripping chamber was carried out in air and hydrogen with nitrogen used as stripping gas. A method is given for determining plasma ion temperature, considering the degree of isotropy of the Maxwell ion distribution function by velocity. (R.V.J.)

45226 LASER INTERFEROMETRIC MEASUREMENTS OF ELECTRON DENSITY IN SHOCK-WAVE PLASMA. Konjevic, N.; Cirkovic, Lj.; Labat, J. Fizika (Zagreb); 2: 121-8 (1970).

The application of a laser interferometric technique is described for the investigation of electron density behind the reflected shock wave in an electromagnetic, T-type shock tube. The tube was filled with the mixture of argon and hydrogen (9 : 1) to the pressure of 1 torr. The advantages and limitations of the method are discussed. The electron density in plasma (2.11 to 3.57×10^{17} cm^{-3}) was determined simultaneously by the laser interferometry at two different wavelengths and by the measurements of the Stark broadening parameters of Hβ line. Results of these two sets of measurements agree within 4%. (auth)

45227 OPTICAL MEASUREMENT OF HIGH-TEMPERATURE PLASMAS IN SCALLOPED-TORUS-TYPE FUSION ASSEMBLY. Matsuda, Nisaku (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Toshiba Rebyu; 25: 909-13(Jul 1970). (In Japanese).

An experimental device for confining and heating tenuous hot plasma has been studied with the basic ideas of the scalloped torus. The spectroscopic data of helium spectrum lines emitted from plasmas are summarized. The principal variables are the values of the confining field (4 to 7.5 kG), the ohmic heating field (1.4 to 2.3 volt/cm) and the initial gas pressure (1 to 13 m torr). Another parameter is the shape of the heating field wave. Upon application of electric fields, the plasma current reaches 400 to 1,390 A. A fast interference spectrometer was developed and used for the investigation of spectral line profiles, i.e., for measuring ion temperatures. The results obtained were: the ion temperature of 5.7×10^4 °K (derived from Doppler line methods of He II λ 4686 Å), and electron temperatures of 1.4×10^5 to 7.5×10^5 °K (derived from the relative intensities of corresponding singlet and triplet lines in the spectrum). (auth) (Japan)

45228 TWO-PROBE MEASUREMENT OF THE ELECTRON ENERGY DISTRIBUTION IN NOISY DISCHARGES. Tuma, D. T. (Univ. of California, Irvine). Rev. Sci. Instrum.; 41: 1360-2 (Sep 1970).

A two-probe technique is presented to measure the electron energy distribution in gaseous discharges that contain a large component of random and coherent oscillations. The determination of the electron energy distribution f (E) in a gas discharge is of importance in calculating the excitation and ionization rates in the discharge. (M.O.W.)

45229 MEASUREMENT OF THE ENERGY OF THE PLASMA IN THE T-3 INSTALLATION. Mirnov, S. V. This paper was summarized in At. Energ. (USSR); 26: 458(May 1969) as paper No. 301. (In Russian).

A measurement was made of the total plasma energy E in the T-3 installation. Since the plasma pressure may in general be anisotropic, two energy components must be considered: the $E_\perp$ component transverse to the direction of the stabilizing magnetic field, and the longitudinal $E_\parallel$ component. The value of $E_\perp$ was determined from the diamagnetic effect of the plasma, while $E_\parallel$ was estimated from the equilibrium displacement of the plasma pinch, on the assumption that the current density in the center was no greater than the value allowed by the Kruskal–Shafranov criterion for q = 1. (auth)

45230 SCANNING ANALYZER FOR DETERMINING CHARACTERISTICS OF AN IONIZED PLASMA. Holt, James F. (to Secretary of the Air Force). U. S. Patent 3,519,927. 7 Jul 1970. Filed 5 Sep 1968.

Apparatus is described for measuring and displaying plasma characteristics such as current density and electron temperature over the cross section of the plasma stream. A rotating apertured scanning disc intercepts the plasma stream and scans it along parallel lines. The plasma particles passing through the apertures of the scanning disc are received by a collector electrode producing a current flow in the electrode circuit which varies in accordance with the current density distribution in the plasma stream. By varying the collector voltage the E – I characteristic for any point may be obtained, from which the electron temperature may be derived. Profiles of both current density and electron temperature are displayed in a gray scale representation on the screen of a kinescope the scanning beam of which is synchronized with the scanning disc. (auth)

45231 ELECTRICAL PROBES FOR PLASMA DIAGNOSTICS. Swift, J. D.; Schwar, M. J. R. New York; American Elsevier Publishing Company, Inc. (1970). 341p. $19.50.

After introducing the basic ideas of the electrical probe method, the circumstances in which carrier flow can be described by single mobility and diffusion motion are discussed. Succeeding chapters include a general probe theory based on Boltzmann's transport equation. The find chapters are concerned with practical details and include a discussion of the factors that influence probe design and choice of circuit, possible effects of probe and plasma perturbation, a brief survey of the behavior of probes under a variety of conditions, and an outline of other plasma diagnostic methods. (M.O.W.)

45232 EFFECTS OF CONTAMINATION ON LANGMUIR PROBE MEASUREMENTS IN GLOW-DISCHARGE PLASMAS. Thomas, T. L.; Battle, E. L. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). J. Appl. Phys.; 41: 3428-32(Jul 1970).

The effects of surface contamination of the surface of Langmuir probes were studied experimentally. These experiments were carried out in three different argon glow discharge tubes. One tube was designed to simulate conditions found in large plasma facilities used in engineering studies, while the other two were designed and prepared in accordance with high-purity laboratory standards. In addition, the effect of a small amount of air on an argon plasma was investigated. The data are presented in the form of original probe traces taken on a two-axis recorder. These data were used to construct curves of contamination versus time and of the logarithm of electron current versus probe voltage. It was found that sufficient contamination is present, even in relatively well-prepared systems, to cause gross errors in probe measurements. The errors are found to be especially insidious in that the self-consistency checks commonly used in Langmuir probe applications do not reveal the presence of contamination. It is concluded that probe measurements will be compromised unless particular attention is given to the problem of maintaining a clean probe. (auth)

45233 INVERSE PROBLEM FOR ELECTROSTATIC PLASMA PROBES. Sajben, M.; Lee, P. H. Y. (California Inst. of Tech., Pasadena). J. Appl. Phys.; 41: 3433-9(Jul 1970).

Electrostatic probe theories are traditionally aimed at predicting probe characteristic curves for specified sets of plasma density, temperature, and potential. The inverse process of determining the plasma properties from a measured current–voltage curve is conventionally done in a fashion involving subjective judgment and resulting in one set of properties for one characteristic. A method is presented that eliminates subjective factors altogether and yields one set of properties for each point of the characteristic curve. By averaging, the accuracy and reliability of the data are considerably increased. The method is based on the replacement of conventional dimensionless variables by new, experimentally convenient ones and expressing the results of a given theory in terms of the new variables. The method is applied to a cylindrical probe in a collision-free Maxwellian plasma at rest. It is demonstrated, by way of an example, that the results of the inverse solution are consistent with the direct problem. The principle of the inversion is applicable to a wide variety of probe theories. (auth)

45234 SPECTROSCOPIC MEASUREMENTS ON LASER-PRODUCED LiH PLASMAS. Seka, W.; Schwob, J. L.; Breton, C. (EURATOM-CEA, Fontenay-aux-Roses, France). J. Appl. Phys.; 41: 3440-1(Jul 1970).

Spectroscopic measurements in the extreme uv and visible were carried out on a plasma produced by giant-laser impact on small LiH pellets suspended in vacuum. The experimental results indicate a fast-expanding periphery containing Li, H, and some oxygen impurities, and a plasma core with a smaller mean expansion velocity. The latter gives rise to a sequence of emission lines due to ions of successively decreasing charge. This plasma core is completely recombined after about 100 to 150 nsec. (auth)

45235 DETERMINATION BY OPTICAL METHODS OF THE SPEED AND THE LOCAL ELECTRON DENSITY OF A SUPERSONIC FLOW OF IONIZED ARGON SUBJECTED TO LAPLACIAN ACCELERATING FORCES. Fontaine, Bernard; Forestier, Bernard; Bouesc, Jacky (Institut de Mecanique des Fluides, Marseille). Compt. Rend., Ser. B; 271: 93-6(15 Jul 1970). (In French).

Experimental conditions are described and the general shape of the trajectories discussed. From the optical images obtained by this method, the speed of the plasma and the speed of the initial burst are determined for each point in the interaction zone. The luminosity curve of the plasma and the profile of the electron density are given. (tr-auth) (France)

Kinetics (General)

Refer also to abstract 45052.

45236 (AEC-tr-7159) STUDIES OF THE THRESHOLD OF HIGH-FREQUENCY INSTABILITIES DURING ELECTRON BEAM INTERACTIONS WITH PLASMA. Bogdankevich, L. S.; Rayzer, M. D.; Rukhadze, A. A.; Trelkov, P. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-18102. 23p. Dep. CFSTI.

An abstract of this paper, prepared from the original Russian report, appeared as NSA 24: 12799.

45237 AUTOMATIC CONTROL SYSTEM OF THE AMICOM 8000-kw PLASMA FACILITY. Dickerson, L. L. (Army Missile Command, Redstone Arsenal, Ala.). J. Spacecraft Rockets; 7: 983-6(Aug 1970).

A description is given of the control system for the MICOM 8000-kW plasma facility. This includes a set of six 65-kW, 3-phase, phase-controlled thyristor amplifiers which, together with control and digital multiplexing components, regulate the field currents of the six power generators in the plasma facility. Problems encountered in the design of the control system were related to the establishment of stability, accuracy (2%) and speed of response (system time constant ≈0.13 sec) in the facility. Sufficient details are given to permit a working understanding of the system's structure and design concepts. (auth)

Kinetics (Experimental)

Refer also to abstracts 44840, 44849, and 45000.

45238 (AEC-tr-7164) COLLECTIVE INTERACTIONS IN A FAST THETATRON. El'Khalafavi, T. A.; Suprunenko, V. A.; Ternopol, A. M.; Khafiz, L.; Yuzef, A. M.; Burgam, A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-69-32. 20p. Dep. CFSTI.

An abstract of this paper, prepared from the original Russian report, appeared as NSA 24: 15298.

45239 (AEC-tr-7165) COLLECTIVE INTERACTIONS IN LOW-DENSITY PLASMA WITH HIGH-CURRENT GAS DISCHARGE. Masud, M. M. M.; Maznichenko, M. E.; Reva, N. I.; Suprunenko, V. A.; Sukhomolin, E. A.; Ternopol, A. M.; Tyupa, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov, Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-69-31. 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original Russian report, appeared as NSA 24: 15297.

45240 DIRECT OBSERVATION OF INTERACTION BETWEEN PLASMA IONS AND GRID-EXCITED PULSES IN A Q MACHINE. Andersen, S. A.; Jensen, V. O.; Michelsen, P.; Nielsen, P. (Danish Atomic Energy Commission, Roskilde). Phys. Lett., 32A: 413-14(24 Aug 1970).

Change in the velocity distribution function caused by interaction between ions and density pulses in a Q machine is observed experimentally. (auth)

45241 INVESTIGATION OF EQUILIBRIUM IN AN ARGON PLASMA. Bober, L.; Tankin, R. S. (Northwestern Univ., Evanston, Ill.). J. Quant. Spectrosc. Radiative Transfer; 10: 991-1000(Sep 1970).

Spectroscopic measurements of the 7635.10 Ar I line were made on an argon plasma generated in a free burning arc at 0.1 atm, and 1.0 atm. By making absolute line intensity measurements and assuming local thermal equilibrium (LTE) the transition probabilities at these three pressures were obtained. They varied from 1.37×10^7 sec^{-1} at 0.1 atm to 2.3×10^7 sec^{-1} at 1.0 atm, indicating the plasma was not in LTE. Extrapolating the data to higher pressures indicates that LTE occurs at about 3 atm (electron number density $\sim 10^{18}$). The transition probability is then determined to be 2.7×10^7 sec^{-1}. The plasma is believed to be in "Partial LTE" and the overpopulation of the ground state level of the atoms agrees with the theoretical results for a hydrogen plasma. (auth) (UK)

45242 EXPERIMENTAL INVESTIGATION OF THE SHOCK STRUCTURE IN A PARTIALLY IONIZED GAS. Kirchhoff, Robert Henry. Berkeley, Calif.; Univ. of California (1969). 111p. University Microfilms Order No. 70-6143.

Thesis

Shock structure experiments were carried out in a radio-frequency heated, steady-state, low density, partially ionized argon plasma jet. The primary diagnostic tool was the aligned cylindrical free molecule Langmuir probe used to probe a normal shock wave. Spatial resolution was 13% of the heavy particle shock thickness, thus details of electron temperature, ion number density, and plasma potential are available through the shock. The electron temperature rise was observed to precede the heavy-particle shock. The plasma potential converted from floating potential according to the theory of Laframboise was in substantial agreement with changes in plasma potential obtained from a numerical quadrature of the generalized Ohm's Law assuming zero current. A quantitative explanation of the dark space observed to precede partially ionized gas shocks is provided by comparing the collisional–radiative recombination rate calculated with observed electron temperature and number density to the luminosity of the flow. The result of integrating the electron energy equation, including the effect of recombination energy transfer, was compared to the data to show that the fraction of ionization energy given to the electron gas was not constant through the shock. (Diss. Abstr. Int., B)

45243 DRIFT VELOCITIES OF ELECTRONS IN THE POSITIVE COLUMN OF A NEON DISCHARGE. Sugawara, M.; Chen, C. J. (Jet Propulsion Lab., Pasadena, Calif.). J. Appl. Phys.; 41: 3442-5(Jul 1970).

Drift velocities of electrons in a gaseous neon plasma were obtained by measuring the discharge current, radial density profile of electrons, and axial electric field in the positive column of a neon discharge for E/n_a(V cm^2) values ranging between 2.8×10^{-17} and 2.4×10^{-16} at a temperature of 300°K. The data agree very well with that of the previous workers. The validity of the Langmuir probe measurement for the electron densities in this experiment is discussed in detail. (auth)

45244 PRODUCTION AND STUDY OF AN ALKALI PLASMA WITH NEGATIVE IONS. Hashmi, M.; van der Houven van Oordt, A. J.; Wegrowe, J.-G. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). J. Appl. Phys.; 41: 3446-7(Jul 1970).

The method of contact ionization is used to produce a three-component plasma (Cs^+, Cl^-, e^-) in the Q-device BARBARA using a beam of cesium chloride. The end-plate temperature controls the concentration of Cl^-, which can be varied in a wide range. The density of negative ions is obtained from the difference between the positive ion density given by a Langmuir probe and the electron density given by a microwave resonator. A high concentration of negative ions is achieved. (auth)

Kinetics (Theoretical)

45245 (SU-IPR-373) PLASMA COMPUTER SIMULATION IN CYLINDRICAL GEOMETRY WITH AZIMUTHAL SYMMETRY. Le Bail, Roland Claude Joseph (Stanford Univ., Calif. Inst. for Plasma Research). Jun 1970. Contract AT(04-3)-799. 127p. Dep. CFSTI.

A computer program that simulates the behavior of a quasi-electrostatic plasma in cylindrical geometry with azimuthal symmetry was developed. The model is represented by an assembly of approximately 2000 charged rings confined by a fixed magnetic-mirror field configuration. The motion of the particles under the influence of their self-consistent electric field and the imposed magnetic field is computed, stepwise in time, according to Newton's law of motion. The bulk of the research has been directed toward accuracy and speed both for the solution of Poisson's equation and the equations of motion. The program uses a nine-point formula for the finite counterpart of Poisson's equation which, for a slight increase in computer time, is exact up to the fourth order in both the r and z direction. The solution of this two-dimensional finite-difference approximation is obtained with the help of a fast reversal mapping, which for simple geometric configurations is faster than the best iterative methods. The technique used minimizes the number of multiplications for a mesh having a special number of cells along the z axis; in the computer program a 64 (axial) by N (radial) mesh was used. For the equations of motion, extensive use of area weighting techniques was made both for the evaluation of the magnetic field and for the derivation of the electric field components. Finally, special care was taken in order to reduce the computer noise in the neighborhood of the axis of symmetry. Preliminary accuracy checks were made on an IBM 360/67 computer both for the Poisson solver and for the particles mover; in the latter case energy conservation was verified for a single particle experiment and also monitored the adiabatic invariants of the motion. A final computer experiment was performed on a CDC 6600 computer to study the effect of electrostatic interactions on mirror confinement. The total energy of the plasma was monitored and the results of the investigation displayed in a motion picture, which shows the position of every plasma particle and the shape of the potential surface. The periodic buildup of peaked potential at the center of the system, combined with the anisotropy introduced by the magnetic-mirror field configuration, was found to explain a possible loss-cone mechanism. (auth)

45246 SHOCK INTEGRAL OF A MIXTURE OF FERMI GASES WITH COULOMB INTERACTIONS. Draganu, Mircea. Compt. Rend., Ser. B; 270: 1445-8(8 Jun 1970). (In French).

An equation analogous to the Landau integral equation for classical gases is derived for the shock terms of a mixture of Fermi gases with Coulomb interactions. (France)

45247 PLASMA DIFFUSION IN TOROIDAL SYSTEMS WITH ANISOTROPIC PRESSURE. Dobrowolny, M.; Pogutse, O. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett., 32A: 417-18(24 Aug 1970).

The problem of resistive diffusion of a plasma with anisotropic pressure in a toroidal system is considered. The diffusion decreases, with respect to the isotropic pressure case, when $p_{||} > p_{\perp}$ and increases in the opposite case. (auth)

45248 NEW REPRESENTATION FOR THE PLASMA CONDUCTIVITY TENSOR IN A MAGNETIC FIELD. Fried, Burton D.; Hedrick, Clyde L. (Univ. of California, Los Angeles). pp 345-56 of Quanta. /Freund, P. G. O. (ed.). Chicago: University of Chicago Press (1970).

General expressions are given for the elements of the conductivity tensor in which no Bessel function expansions are used, thus eliminating the necessity for subsequent resumming. The closed form expressions given are valid for any particle distribution functions. (M.O.W.)

45249 ELECTRIC DRAG. Fournier, G. (National d'Etudes et de Recherches Aerospatiales, Chatillon, France). Planet. Space Sci.; 18: 1035-41(Jul 1970).

Starting from a hybrid calculus of the collisionless plasma flow around a cylinder, the Coulombian drag on the body is computed. Three methods are compared and their results check the validity of the calculus. However, one of these methods is shown to give a poor accuracy. (auth) (UK)

45250 ENERGY TRANSFER MECHANISMS IN A PLASMA. Helrich, Carl Sanfrid Jr. Evanston, Ill.; Northwestern Univ. (1969). 67p. University Microfilms Order No. 70-6476.

Thesis.

A derivation from first principles of the methods of description of energy flow in a plasma is conducted, illuminating the various forms of the energy and the mechanisms by which these forms are exchanged. A collection of point charged particles obeying Newton's laws of motion and the Maxwell equations is initially considered. From this level, by taking ensemble averages and introducing various constructions for physical quantities, the "Boltzmann" and hydrodynamical levels are attained. Finally, macroscopic and fluctuating, or internal, waves passing through the plasma are considered. In each case an equation of transfer including both field and particle energies is derived. Standard forms of the momentum and energy equations are obtained if "collisions" are assumed to be elastic. (Diss. Abstr. Int., B)

45251 PAIR DISTRIBUTION FUNCTION FOR A CLASSICAL COULOMB GAS. del Rio, Fernando. Berkeley, Calif.; Univ. of California (1969). 119p. University Microfilms Order No. 70-6086.

Thesis.

The pair distribution function for a classical one-component plasma is obtained by summing terms of the Montroll–Mayer cluster expansion of g(r) for the Coulomb potential. The diagrammatic method used to describe the perturbation expansion is essentially the nodal expansion of Abe in which chains of Coulomb interactions are summed to give new cluster integrals in which only the screened Coulomb potential appears. From the resulting nodal expansion a simple class of diagrams, those with chains and bubbles in series, is found to give the long distance limit of g(r) for values of the plasma coupling parameter, $\Lambda = \frac{1}{4}\pi n\lambda_D^3$, into the intermediate coupling regime, $1 < \Lambda < 10$. This class of diagrams is summed and rigorous results for the asymptotic form of g(r) are obtained; the theory gives the Debye–Huckel result for weak coupling, $\Lambda < 1$, and a modified Debye form for intermediate coupling, $\Lambda > 1$. Exact results for g(r) are obtained to order $\Lambda^2 \log \Lambda$. The analysis shows that for Λ larger than a critical value Λ_c, which is about 4 in the simplest theory, that the long distance form of g(r) changes from the Debye form to a damped oscillatory form in qualitative agreement with the Monte Carlo calculations of Brush, Sahlin, and Teller. Thus a relatively simple theory gives a qualitative indication of the onset of short range order in the classical Coulomb gas as the density is increased. Numerical calculations done on the simplest form of our result agree moderately well with the Monte Carlo results over the entire range of r for $\Lambda < 2$ and represent a substantial improvement over the nonlinear Debye–Huckel result. Iteration procedures for summing more classes of diagrams in the expansion are worked out and both the Percus–Yevick and the hypernetted chain equations for g(r) are derived. Also the expansion method is applied to the three-particle correlation function, and it is found that the Kirkwood superposition approximation remains fairly good even for large Λ. Finally, the diagrammatic summation procedure is applied to the classical two component of finite size positive and negative charges, and a modification of the Debye screening length is obtained. (Diss. Abstr. Int., B)

45252 ANALOG COMPUTER SIMULATION IN PLASMA PHYSICS. Shen, K.; Alton, E. D.; Hsuan, H. C. S. (Univ. of Iowa, Iowa City). Amer. J. Phys.; 38: 1133-5(Sep 1970).

It is shown that analog computer simulation can be used as a convenient tool to demonstrate visually some fundamental properties of plasma physics. In this study, it is also observed that a new plasma drift mechanism exists in a nonstatic anisotropic plasma. (auth)

45253 STRUCTURE OF A SINGLY IONIZING CURRENT SHEET PROPAGATING IN A LOW DENSITY GAS. Pert, G. J. (Univ. of Alberta, Edmonton). Can. J. Phys.; 48: 1769-80 (1 Aug 1970).

The structure of a singly ionizing current sheet is examined under steady-state conditions. Convergent solutions are only found in the presence of ambient transverse magnetic and electric fields. A collision-free model is used to approximate to the ionization region in the front. This solution is cut off at the electron mean free path and matched to a collision-dominated magnetohydrodynamic two-fluid calculation for the back of the sheet. The conditions for the establishment of a steady state are examined for these solutions. (auth)

45254 KINETIC THEORY OF SUBSONIC AND SUPERSONIC TRANSPORT PROCESSES IN WEAKLY IONIZED GASES. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Nuovo Cim.; 68B: 189-207(11 Aug 1970).

A statistical theory of the intercomponent momentum and energy exchange in nonisothermal many-component systems is presented, in which the particles interact according to the elastic-sphere model. It is shown that the intercomponent transport processes depend, through transcendental functions, on the drift velocities of the components, simple functional relations resulting for infrasonic and ultrasonic drift velocities. As an application, a theoretical description is given of: (1) the nonlinear electrical conduction of weakly ionized plasmas in strong electric fields, (2) the intercomponent thermal nonequilibrium of a weakly ionized plasma in strong electric fields, and (3) the relaxation of energetic test particles by collisions with field particles having an equilibrium velocity distribution. By means of these concrete examples, the existence of subsonic and supersonic transport processes is discussed, respectively. (auth)

45255 FUNCTIONAL METHOD FOR SOME NONLINEAR PROBLEMS IN PLASMA PHYSICS AND THERMONUCLEAR FUSION. Ogunlana, J. (Univ. of California, San Diego, La Jolla). Nuovo Cim.; 69B: 11-19(11 Sep 1970).

A Volterra–Wiener functional scheme for solving nonlinear equations is presented. Several problems in plasma physics and thermonuclear fusion that can be solved accurately by using this method are discussed. A nonlinear kinetic-theory problem of plasma shocks is solved as an example. (auth)

45256 STUDY OF THE VARIATIONS IN THE AERODYNAMIC FLOW PARAMETERS OF IONIZED ARGON SUBJECTED TO LAPLACIAN ACCELERATING FORCES. Forestier, Bernard; Fontaine, Bernard; Bournot, Philippe; Parraud, Paul (Institut de Mecanique des Fluides, Marseille). Compt. Rend., Ser. B; 271: 198-201 (20 Jul 1970). (In French).

Equations defining the interaction are presented. Integration of these equations yields two dimensionless coefficients independently measurable in each experiment. These coefficients allow the determination of the theoretical values corresponding to all the characteristic parameters related to the outflow from the interaction zone. The solution of the system of equations depends only on the values of the two coefficients and the initial data. (tr-auth) (France)

Production

45257 PLASMAS AND ION SOURCES. Delcroix, Jean-Loup (Laboratoire de Physique des Plasmas, Orsay, France). pp 1-40 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France: I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The principal properties of plasmas are briefly reviewed, and emphasis is given on phenomena that are important in ion sources. The difficulty lies essentially in the fact that plasmas in ion sources are of a complicated geometry and are surrounded with solid walls (the extraction system first). Owing to these walls, the boundary conditions prescribed are rather complex and the plasma physicists generally describe simpler situations (infinite plasmas, cylindrical column, plane walls...). (France)

45258 EFFECT OF MAGNETIC FIELD ON THE PLASMA IN A DUOPLASMATRON. Bose, D. K.; Nagchaudhuri, B. D. (Saha Inst. of Nuclear Physics, Calcutta). pp 101-9 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

Some measurements of the argon plasma parameters in a duoplasmatron discharge at various values of the magnetic field are reported. The observed data indicate the existence of low-frequency oscillations and of an associated enhanced diffusion for a magnetic field below 1 kg. An explanation of the results is attempted in the light of Hoh theory. (France)

45259 DESIGN OF AN ION SOURCE FOR A SYNTHETIC PLASMA. Freeston, I. L. (Univ. of Sheffield, Eng.). pp 425-35 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The theory of a grid system to collimate the ion beam emitted by a cylindrical ion emitter is presented, and it is shown that such a system can be used to produce a uniform ion beam plasma. An experimental grid system was made and tested, and showed good agreement with theory. However, the properties of the collimator were found to depend on the resistivity of the ion emitter, which is investigated. (auth) (France)

45260 INFLUENCE OF INELASTIC COLLISIONS OF ELECTRONS WITH ATOMS ON THE RATE OF NONEQUILIBRIUM IONIZATION. Stakhanov, I. P.; Cherkovets, V. E. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 43-6(May-Jun 1970). (In Russian).

Processes taking place near low-voltage arc cathodes were studied as functions of the ratio between Coulomb length of the free electron trajectories and the length of free trajectories in relation to the elastic and inelastic electron scattering on atoms. Equations were obtained for corrections of Maxwell distribution function and local and total rate of nonequilibrium ionization, taking into account inelastic collisions of electrons with atoms. (tr-auth)

45261 DEVICE FOR THE PRODUCTION OF AN EXTENDED HOMOGENEOUS FIELD-FREE SPHERICAL PLASMA. de Hoog, A. C.; Schott, L. (Univ. of Saskatchewan, Saskatoon). Rev. Sci. Instrum.; 41: 1340-2(Sep 1970).

A new plasma source was designed and tested that is capable of producing a stationary, quiescent spherical diffusion plasma of 69 cm diameter. This plasma is free of electric currents, and the electric fields in it can be kept below 10 mV/cm. Electron temperatures between 10^3 and 3×10^3 K and plasma densities between 10^9 and 10^{10} cm^{-3} were measured with a Langmuir probe in the pressure range 0.1 to 10^{-4} torr. Radial variations of the plasma density smaller than 10% over about two thirds of the plasma radius were observed in argon at pressures between 10^{-2} and 10^{-4} torr. (auth)

Stability

45262 (COO-2081-1(Rev.)) NONLINEAR PHENOMENA IN COLLISIONLESS PLASMAS. Progress Report No. 1. (Colorado Univ., Boulder. Dept. of Astro-Geophysics). Jul 1970. Contract AT(11-1)-2081. 6p. Dep. CFSTI.

Research was directed toward the basic understanding of the nonlinear dynamics of unstable loss-cone modes, and low-frequency flute convective cells. Brief summaries of work on each are given. (M.O.W.)

45263 (INR-P-1188) INFLUENCE OF A COLLISIONAL PLASMA BACKGROUND ON THE TWO-STREAM INSTABILITY. Infeld, E.; Skorupski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 4p. (CONF-700817-1). Dep. CFSTI (U. S. Sales Only).

From 4th European Conference on Controlled Fusion and Plasma Physics, Rome, Italy.

Classification of the two-stream instability into convective and absolute for two hot streams and a collisional plasma background is outlined. The case of cold streams is solved completely. The collisional background has the effect of quenching the absolute instability for some stream parameters. (auth)

45264 (ORNL-4545, pp 9-37) PLASMA THEORY AND COMPUTATION. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

ELECTRON BEAMS — interactions with plasma, turbulent ion heating in, (T)
— interactions with plasma density gradients, one-dimensional, (T)
MAGNETIC MIRROR MACHINES — plasma stability in ELMO, maximum pressure for, (T)
MAGNETIC MIRRORS — plasma microinstabilities in model, (T)
— plasma wave coupling in, modification of electrostatic dispersion relation for, (T)
ORMAK DEVICES — plasma equilibria theory for, magnetohydrodynamic, (T)
PLASMA — stability in model mirror fields, micro-, (T)
— wave coupling in mirror geometries, modification of electrostatic dispersion relation for, (T)
— stability in ELMO device, maximum pressure for, (T)
— stability of multicomponent hot electron, electrostatic, (T)
— equilibrium in Tokamak devices, magnetohydrodynamic, (T)
— electron beam interactions with, turbulent ion heating in, (T)
— electron beam interactions with density gradients in, one-dimensional, (T)
— heating at electron cyclotron frequencies, relativistic and finite cyclotron radius effects in, (T)
— kinetic theory of, numerical solution of nonlinear Vlasov equation, (T)
TOKAMAK DEVICES — plasma equilibria theory for, magnetohydrodynamic, (T) (M.O.W.)

45265 (ORNL-4545, pp 38-57) TARGET PLASMAS. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

MAGNETIC MIRROR MACHINES — research on INTEREM facility, 1969
— plasma instabilities in INTEREM facility
— plasma diagnostics in IMP facility, apparatus design for
— plasma trapping calculations for IMP facility, (T)
PLASMA — confinement in IMP facility, trapping calculation for, (T)
— stability in INTEREM facility
— diagnostics in IMP facility, apparatus design for (M.O.W.)

45266 (ORNL-4545, pp 116-23) INJECTION AND ACCUMULATION. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

The steady-state instability behavior at low plasma density (gas breakup operation) and the losses from the two distinct groups of energetic trapped protons are discussed for a 540-keV H_2^+ beam injected into the DCX-2 device. (M.O.W.)

45267 (ORNL-tr-2352) CORRELATIONAL METHOD OF STUDYING PLASMA INSTABILITIES IN THE TOKAMAK-3 APPARATUS. Mirnov, S. V.; Semenov, I. B. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated for Oak Ridge National Lab., Tenn., from report IAE-1907. 20p. Dep. CFSTI.

Results of correlation measurements of the spatial fluctuations of the magnetic fields of the discharge current in the Tokamak-3 device are presented. A system of 18 magnetic probes located on the external surface of the discharge chamber was used as the detectors. The subtraction of their readings by means of a balance scheme with subsequent squaring and averaging made it possible to obtain the signal proportional to $1-f(\varphi,\psi)$, at any given time, where f = correlation function of the fluctuations of the magnetic fields, and φ and ψ = toroidal angular coordinates. The results of the corresponding measurements are presented for several discharge systems in the Tokamak-3 apparatus. With the assumption that the observed fluctuations are related to rotation of the plasma having a nonuniform current density distribution in the vicinity of the boundary, it is possible to link their origin to the development of hydromagnetic instabilities of the highest mode. Measurement of the frequency spectrum of the observed fluctuations (in the 2 to 15-kHz range) allows one, in individual cases, to estimate the rotational velocity of the plasma. (auth)

45268 EFFECT OF HELICON ON PLASMA INSTABILITIES. Ivanov, A. A.; Murav'ev, V. F. (Moscow Physical-Technical Inst.). Zh. Eksp. Teor. Fiz.; 59: 254-61(Jul 1970). (In Russian).

The effect of helicon moving along a stationary magnetic field H_0 on the losscone and drift-loss-cone instabilities of a plasma is investigated. It is shown that at a relatively low field strength of the helicon the instabilities may be suppressed. (auth)

45269 NONLINEAR STAGES OF HOSE INSTABILITIES. Berezin, Yu. A. Zh. Priki. Mekh. Tekh. Fiz.; No. 3, 3-10(May-Jun 1970). (In Russian).

The one-dimensional problem of hose instability in anisotropic plasma and its influence on the structure of shock waves is analyzed. It is shown that, at comparably small intervals after the beginning of instability, regular oscillations take place in the magnetic field which at large intervals of time become stochastic and convert into a turbulent system. (tr-auth)

45270 POSSIBILITY OF STABILIZING FLUTE INSTABILITY OF A PLASMA WITH THE AID OF CONTROLLED ELECTRON BEAMS. Chuyanov, V. A. JETP Lett. (USSR) (Engl. Transl.); 11: 414-16(20 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 598-600(20 Jun 1970).

The change in the electron-beam density in the continuity equation for the electrons was taken into account to introduce a term of the form $(1/ev_b)(\partial j/\partial t)$, where v_b is the velocity of the electrons in the beam, e is the electron charge, and j is the density of the electron current. Quasi-classical approximations were used in the stabilization analysis for short-wave oscillations. (M.O.W.)

Thermonuclear Processes

Refer also to abstracts 44346, 45168, 45667, and 45669.

45271 (AEC-tr-7158) DEVELOPMENT AND CONSTRUCTION OF MAGNETIC SYSTEMS FOR THE "URAGAN" STELLARATOR AND STUDIES OF MAGNETIC SURFACES OF LARGE "LATITUDE". Aleksin, V. F.; Biryukov, O. V.; Vishnevetskii, V. N.; (and others). (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-69-39. 50p. Dep. CFSTI.

An abstract of this paper, prepared from the original Russian report, appeared as NSA 24: 15350.

45272 (ANL-Trans-842) NUCLEAR DATA FOR THERMONUCLEAR REACTORS. Chernilin, Yu. F.; Yan'kov, G. B. Translated for Argonne National Lab., Ill., from Paper CN-26/104 of Second International Conference on Nuclear Data for Reactors, IAEA, Helsinki, Finland, June 15-19, 1970. 38p. (CONF-700605-4). Dep. CFSTI.

On the basis of an examination of the fundamental plan for a thermonuclear reactor, the problem of the nuclear data necessary for its creation is discussed. An analysis is presented of the nuclear data published through 1969 for the three basic materials that have been proposed for use in a thermonuclear reactor: ^{6}Li, ^{7}Li, and Nb. The requirements for nuclear data for these reactors are examined in the concluding part of the report. (auth)

45273 (NP-18378) NEW SCHEME FOR A TWO-INLET STELLARATOR. Preprint No. 31. Danilkin, I. S.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1970. 31p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A new design is discussed for a two-inlet stellerator capable, in principle, of satisfying new requirements for plasma containment. The new system exhibits a higher stability of magnetic field configuration, and is less influenced by the toroidality and other faults of the construction; also, it is capable of more efficient particle containment and has a latitude of $\theta \geq 0.1$. The construction of the system provides easy access to the operating area filled with plasma and offers good vacuum necessary for the experiments. The stellarator is very economical in using the magnetic field at low mechanical loads. Containment of plasma in the stellarator field under exceptionally clean conditions was achieved. (R.V.J.)

45274 (ORNL-4545, pp 138-46) ENERGETIC-PARTICLE INJECTION. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

ION SOURCES—design for intense low-energy proton beams, for plasma experiments

PROTON BEAMS—production of intense low-energy, for plasma injection experiments (M.O.W.)

45275 (ORNL-4545, pp 168-71) FUSION FEASIBILITY. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

Brief summaries of research being conducted on the following areas are given: (1) fusion reactor materials, (2) neutronics, and (3) mirror feasibility. (M.O.W.)

45276 MAGNETRON-TYPE ANNULAR ION SOURCE. Bariaud, Andre; Druaux, Jean; Prevot, Francois (EURATOM-CEA, Fontenay-aux-Roses, France). pp 243-56 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The annular source built to be used as an injector of H_3^+ ions to produce a plasma at high temperature in a magnetic mirror configuration allows the injection of a plane sheet of convergent ions towards the center of the configuration across the magnetic field. At 50 to 100 keV accelerating voltage, the space charge effects are negligible owing to a very large surface extraction. In the source with a crossed field discharge the gas ionization is due to the azimuthal drift of electrons which break down at low pressure and the discharge is homogeneous if the pressure is well distributed along the ring. The experiments were performed first with a 90 cm diameter source and later with a 240 cm diameter in the same way. (France)

45277 ION SOURCE DEVELOPMENT FOR THERMONUCLEAR RESEARCH. Davis, R. C.; Kelley, G. G.; Morgan, O. B. (Oak Ridge National Lab., Tenn.). pp 259-70 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

This work is concerned with the design of energetic particle injectors throughout an energy range from ~1 to 600 keV. The basic ion sources are from a variety of ion sources that originated either from the duoplasmatron of von Ardenne or the four-electrode ion source of Demirkhanov and associates; these have been modified extensively during this development to satisfy the demands of the particle injectors. The resulting ion sources along with the reasons for their present design and their performance and basic limitations are discussed. A proposed hydrogen cluster ion source based on the work of Becker and associates is also discussed. (France)

45278 INVESTIGATIONS ON ION SOURCES FOR HALL ION ACCELERATORS. Zeyfang, Eberhard (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart). pp 497-506 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

Two types on ion sources have been constructed; both work on Ar gas and use a high-current glow discharge with a heated cathode. The first one uses a directly heated thoriated tungsten wire as cathode, the second one an indirectly heated hollow cathode made of the dispenser material. The mass flow rate can be varied for both ion sources up to 10^{-6} kg/sec. At the maximum flow rate, the pressure in the discharge region decreases from 1 to 2 torr at the input to 0.1 torr at the output. Measurements of the current-voltage characteristics were carried out on both sources; two different mechanisms of ion generation were observed. Ion source 1 is operated at rather low current densities (~7A/cm^2), however, the ionization efficiency is good at low degrees of ionization as the electrons have energies of 100 to 150 eV. Ion source 2 is operated at very high current densities, up to 200 A/cm^2, therefore high rates of ionization, up to 90%, can be obtained. (France)

45279 INTENSE ION BEAM WITH VERY LOW EXTRACTION VOLTAGE. Consolino, J.; Geller, R.; Leroy, C. pp 537-47 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

An original type of slow ion source with strong intensity is reported. The ions of the beam generated in the electron cyclotron hf resonance structure of CIRCE device are extracted. Strong ion beams are thus obtained. Several tens of mA/cm^2 may be extracted with about a hundred volt. (France)

45280 STABILITY ANALYSIS OF A LEVITATED SUPERCONDUCTING CURRENT RING STABILIZED BY FEEDBACK AND EDDY CURRENTS. Woods, C. H.; Cooper, R. K.; Neil, V. K.; Taylor, C. E. (Univ. of California, Livermore). J. Appl. Phys.; 41: 3295-3305(Jul 1970).

A stability analysis is presented for the superconducting levitron stabilized partly by feedback and partly by magnetic coupling to metal plates placed symmetrically above and below the current

ring. The system is so designed that eddy currents in the plates provide sufficient damping to limit the velocity of the ring to safe values in case of loss of control. The magnetic field associated with the feedback system must diffuse through the plates, which tends to handicap the feedback process and complicate the stability analysis. While levitated current rings stabilized by feedback normally require a component of stabilizing current proportional to the ring velocity to produce artificial damping, the present system is found to be stable without such a velocity-dependent component. (auth)

45281 PRODUCTION OF STRONG TOROIDAL FIELDS BY COMPRESSION OF MAGNETIC FLUX. Alikhanov, S. G.; Belan, V. G. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 47-50(May-Jun 1970). (In Russian).

Production of megagauss toroidal magnetic fields by means of flux compression is discussed. Experimental data obtained showed that it is possible to achieve more than 20-fold amplification of toroidal fields by magnetic current compression. A closed configuration was designed for plasma confinement and heating by magnetic fields. Longitudinal magnetic field compression, which was also accelerated by magnetic pressure, produced stable motion and good symmetry of collapse which are necessary for effective amplification of the field. (tr-auth)

45282 NUCLEAR PERFORMANCE OF FUSION REACTOR BLANKETS. Steiner, D. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 83-92(Jul 1970).

The neutronic behavior of fusion reactor blankets is discussed, and transport-theory calculations are presented for two blanket designs. The areas investigated are (1) tritium breeding, (2) nuclear heating, and (3) neutron irradiation effects within the vacuum wall of the blanket, i.e., neutron-induced (a) atom displacements and (b) helium and hydrogen production. The two blanket designs considered consist of niobium as the vacuum wall and structural material, lithium or lithium in combination with lithium–beryllium fluoride (called "flibe") as the coolant, and graphite as the neutron moderator and reflector. The results indicate that the tritium breeding potential of both designs is promising. The results also show that the tritium breeding and nuclear heating characteristics of the lithium-flibe blanket are inferior to those of the lithium blanket. The calculated atom displacement rates and production rates of helium and hydrogen within the vacuum wall are essentially the same for both blanket designs. (auth)

45283 PLASMA CONTAINMENT MEANS. Drabier, Jacques P.; Kerruish, Kermit D.; Stengel, Linda Folkard; Stengel, Rudolph F. (to Entropy Ltd.). U. S. Patent 3,523,206. 4 Aug 1970. Filed 31 Oct 1967.

A magnetic enclosure is described for the containment of a plasma that comprises a torus having a plurality of star-shaped electromagnetic coil assemblies located in spaced adjacency around and along the circumference of the torus. All of the coils in all of the assemblies are oriented with like poles of all coils facing radially inwardly toward the center of the torus whereby all poles of like polarity face each other with a torus space therebetween. (auth)

45284 ANOTHER APPROACH TO THE INJECTION OF RELATIVISTIC ELECTRONS INTO AN ASTRONLIKE DEVICE. Friedman, Moshe (Cornell Univ., Ithaca, N. Y.). Contract N00014-67-A-0077-0002. Phys. Rev. Lett.; 25: 567-70(31 Aug 1970).

Preliminary investigations of another approach to the injection phase of "Astron"-like devices are reported. A relativistic electron annular beam was passed through a cusped magnetic field with 25% efficiency and produced a rotating electron cloud. Gyrating electron behavior was examined in three magnetic field configurations by diamagnetic loops and x-ray detectors. Reduction of magnetic field intensity ranged from 15 to 32%, and confinement times of 0.4 to 3.0 μsec were obtained, depending upon the field configurations. (auth)

45285 STRONG SHOCK WAVES. Gross, R. A.; Chen, Y. G.; Halmoy, E.; Moriette, P. (Columbia Univ., New York). Contract AF 49(638)-1634. Phys. Rev. Lett.; 25: 575-7(31 Aug 1970).

Shock waves traveling at speeds in excess of 10^6 cm/sec (Mach number ≥ 1000) in deuterium gas at 50 m torr and room temperature ($n_i = 1.3 \times 10^{15}$ cm^{-3}) were created in a 3-m-long, electromagnetically driven coaxial shock tube, and neutrons were observed. (auth)

45286 PENNING DISCHARGE AS A RADIAL ION SOURCE. Rikoski, Richard A. (Univ. of Pennsylvania, Philadelphia); Young, Frederik J. Z. Angew. Math. Phys.; 21: 468-72(25 May 1970).

An easily fabricated ionizer for plasma experiments is described. It is stable against thermal and high voltage stress and can be used for long periods before rebuilding. Anode currents are quite constant with changes in intercathode distance and with changes in the applied field once a minimum field strength is exceeded, thus facilitating usage in experiments where the physical geometry or magnetic field is changed. (auth)

45287 ELECTRODE METAL EFFECTS IN A DEUTERIUM PLASMA Z-PINCH DEVICE. Dazey, M. H.; van Paassen, H. L. L.; Josephson, V. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys.; 41: 3545-6(Jul 1970).

Paraboloidal pinch devices equipped with copper, iron, beryllium, titanium, zirconium, and palladium anodes were studied. The resistance of these anodes to vaporization in the strong pinch was discussed. (M.O.W.)

45288 PRODUCTION OF 3-MOe PULSED MAGNETIC FIELDS BY DISCHARGING A CAPACITOR BANK. Andrianov, A. M.; Demichev, V. F.; Eliseev, G. A.; Levit, P. A. JETP Lett. (USSR) (Engl. Transl.); 11: 402-4(20 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 582-5 (20 Jun 1970).

The current source was a bank of pulsed capacitors with stored energy 25 kJ. The discharge current was in the form of a damped sinusoid with decrement 1×10^5 sec^{-1}. The time of the first half-cycle was 5.7 μsec, and the maximum amplitude was 1.5 MA. The experiments were performed with single-turn solenoids of different materials. Some of the measured field intensities are presented. (M.O.W.)

45289 PRODUCTION OF ION STREAM COMPOSED OF TWO COMPONENTS IN VELOCITY DISTRIBUTION. Honzawa, Tadao (Nagoya Univ., Japan). Kakuyugo Kenkyu; 25: 206-12(Jun 1970). (In Japanese).

Results from a new type source of ion stream composed of two components in energy distribution are presented. For this purpose a diffusion-type plasma source is used that is formed with two arrays of oxide-coated cathode rods and five sheets of metallic mesh grids. The energy distribution of the ion stream is observed with an electrostatic energy analyzer, whose resolution is 4%. Ion streams of argon, helium, nitrogen, and their mixtures were obtained, the energy of which ranged from 50 to 500 eV. The energies of two components of ion stream were determined by the voltages externally applied to two pairs of grids, and their relative intensities were controlled by adjusting the temperatures of the two arrays of cathode rods and/or the potential of the intermediate grid. (auth) (Japan)

Wave Phenomena

Refer also to abstracts 45264 and 45389.

45290 (COO-2081-2) LARGE AMPLITUDE STEADY STATE HARMONIC CYCLOTRON WAVES. Aamodt, R. E. (Colorado Univ., Boulder. Dept. of Astro-Geophysics). May 1970. 21p. Dep. CFSTI.

The spatial dependence of an electron plasma-harmonic ion cyclotron amplifying wave is derived for a steady-state loss-cone simulated system keeping the nonlinear ion effects. The saturation amplitude of the wave is found to be extremely small compared to the available free energy, and the amplitude is found to oscillate over distances long compared to the linear amplifying length. Damping of the wave finally occurs because the wave eventually begins to propagate and resonant ions distort the distribution function into a nonamplifying normal monotone decreasing function. (auth)

45291 (ORNL-4545, pp 104-15) PLASMA PHYSICS. (Oak Ridge National Lab., Tenn.).

From Thermonuclear division annual progress report for period ending December 31, 1969.

Two studies of ion–acoustic waves, one of drift waves and one of an as-yet-unidentified slow wave, were made in a plasma supported by a uniform magnetic field. Electron Landau damping of ion–acoustic waves ($\omega \gg \omega_{ci}$) was investigated, both as a function of frequency and as a function of propagation angle with respect to the magnetic field, and excellent agreement with theory was found. In another experiment, it was found that a negatively pulsed wire probe perpendicular to the magnetic field instantaneously creates an ion-rich sheet along the entire length of the plasma column; ion–acoustic waves that propagate perpendicularly to the magnetic field are simultaneously excited at all points on the ion-rich sheet. The phase velocity of drift waves excited via a grid

in a magnetically supported plasma column and propagating across the column was measured as a function of frequency for $\omega < \omega_{ci}$. Both the observed frequency dependence and frequency cutoff are in good agreement with theory. Finally, an as-yet-unidentified slow wave propagating perpendicular to the magnetic field with a velocity that varies directly as ω_{ci} was observed. (auth)

45292 INTERACTION BETWEEN HIGH AND LOW FREQUENCY WAVES IN NONLINEAR DISPERSE MEDIA. II. Bakai, A. S. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 59: 116-27(Jul 1970). (In Russian).

Stationary operation conditions are studied that consist of a set of high- and low-frequency waves interacting in nonlinear dispersive media in the presence of a high-frequency monochromatic external force. Cases of ordinary and parametric excitation of waves in a medium by an external force are considered. As an example, excitation of Langmuir and ion-acoustic plasma oscillations by an external field is considered. The experimental data available at present can be described by the results obtained here. (auth)

45293 OBSERVATION OF PARAMETRIC AMPLIFICATION OF ALFVEN WAVES. Lehane, J. A.; Paoloni, F. J. (Univ. of Sydney). Phys. Lett., 32A: 409-10(24 Aug 1970).

The amplification of Alfvén waves propagating along a sinusoidally perturbed magnetic field was observed. Results are compared with predictions from the theory of Montgomery and Harding for parametric excitation of these waves. (auth)

45294 WEINBERG METHOD IN THE STUDY OF THE PROPAGATION OF MAGNETOHYDRODYNAMIC WAVES IN NONHOMOGENEOUS MEDIA. Petrus, Octavian (Al. I. Cuza Univ., Iasi). Rev. Roum. Phys.; 167-79(1970).

Weinberg's method (eikonal approximation for magnetohydrodynamics) was used for studying the propagation of magnetohydrodynamic waves in a homogeneous unbounded plasma in the magnetic field of an infinite linear electrical current. Two particular cases are solved in detail: the Alfvén waves and the cylindrical magnetoacoustic waves. For these waves the explicit expressions for amplitudes, phases, and phase and group velocities are given. (auth)

45295 NORMAL-MODE APPROACH TO THE LINEAR OSCILLATIONS OF A NONUNIFORM PLASMA. Sestero, A.; Saitta, L. (EURATOM-CNEN, Frascati, Italy). Nuovo Cim.; 68B: 121-36(11 Aug 1970).

The normal-mode approach is applied to the investigation of small perturbations around the equilibrium for the case of an electron plasma trapped in a one-dimensional potential well. The problem is reduced to studying a linear homogeneous Fredholm integral equation of the 2nd kind, with kernel depending on a parameter. The parameter is essentially the frequency (real or complex) of the collective plasma oscillations, and can assume only certain values, if the solutions are to verify the prescribed conditions at infinity. For the special case of a rectangle-shaped equilibrium distribution function, the problem is reduced to a standard eigenvalue problem for an ordinary differential equation, and a number of results are derived concerning the nature and properties of the permitted oscillation spectrum. (auth)

45296 DISPERSION RELATION IN A PLASMA OF TWO ANTIPARALLEL BEAMS ACROSS A MAGNETIC FIELD. Gheorghe, Viorica (Inst. of Physics, Bucharest). Rev. Roum. Phys.; 15: 219-23(1970).

A general dispersion relation is derived for the waves propagating through a plasma created by two interpenetrating electron beams, immersed in an external magnetic field. The resonances and cutoffs of the principal waves are obtained for $\omega_c t \approx n\pi$ (ω_c is the electron cyclotron frequency). (auth)

45297 THEORY OF TEMPORAL ECHOS IN PLASMA: CASE OF RECTANGULAR PULSES. Dobbertin, Rolf (Paris Univ.) Compt. Rend., Ser. B; 271: 97-9(15 Jul 1970). (In French).

Temporal echos in a plasma are studied for two rectangular pulses of finite amplitude and duration using a ballistic approximation. (tr-auth) (France)

45298 OBSERVATION OF ION-ACOUSTIC WAVES AND DRIFT WAVES IN A HIGH-FREQUENCY ELECTRIC DISCHARGE. Soum, Jean; Vacquie, Serge (Toulouse Univ.). Compt. Rend., Ser. B; 270: 1650-2(29 Jun 1970). (In French).

A high-frequency discharge, when placed in a magnetic induction, becomes a source of low-frequency waves. Ion-acoustic waves, drift waves, or both simultaneously were observed, depending on experimental conditions. (tr-auth) (France)

Shielding

Refer also to abstracts 44163, 44707, 44708, 44765, 44831, 45387, 45634, 45636, 45637, and 45714.

45299 (CEA-N-1209) DIAGRAMS FOR RAPID CALCULATION OF GAMMA PROTECTIONS. ATTENUATION OF THE GAMMA RADIATIONS FROM FISSION PRODUCTS. Fourcade-Cancelle, Nicole (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 18p. (In French). Dep. CFSTI (U. S. Sales Only).

Supplement to report CEA-N-470.

These diagrams give the gamma dose rate (in Rad/hr at 1 meter) produced through different shielding materials by uranium irradiated during 500 days at 1 watt and cooled during periods of time from 1 to 365 days. The materials considered are lead, iron, ordinary and baryte concretes, glass, and lead glasses. These diagrams refer to thermal fission products of ^{235}U but could be used for another irradiated fuel or for fast neutron fission products. (France)

45300 (ORNL-RSIC-26) ATTENUATION PROPERTIES OF CONCRETE FOR SHIELDING OF NEUTRONS OF ENERGY LESS THAN 15 MeV. Schmidt, Fritz A. R. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 153p. Dep. CFSTI.

Literature concerning the attenuation properties of concrete for shielding neutrons of energies up to 15 MeV was reviewed, and calculations of neutron transmission, including the secondary gamma rays, were carried out. In connection with the literature review, analytical formulas were developed that are based on neutron removal-diffusion theory and gamma-ray buildup factors. They provide a reasonable tool to compare shielding properties of different concretes. In view of the unsatisfactory state of available attenuation data, especially the lack of secondary gamma-ray results, calculations were performed by the discrete ordinates method and results are presented for various slab thicknesses, and incident energies and angles. The results show the great importance of the secondary gamma rays for large thicknesses. In the course of the work extensive cross section and other data were compiled. The cross section data are available on computer tape from the Radiation Shielding Information Center. The other data are given in the tables of the report. (auth)

45301 (ORNL-tr-2330) THE CALCULATION OF THE RADIATION FIELD OF A DIRECTIONALLY RADIATION POINT SOURCE OF γ-QUANTA WITH THE METHOD OF MOMENTS. Krueger, F. W. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Kernenergie; 13: 47-54(1970). 18p. Dep. CFSTI.

The extent to which the method of moments can be used for the determination of the field of radiation of a directionally radiating point source of γ-quanta is investigated. For this purpose a suitable computer program was worked out for the ZRA I. As a test case the propagation of 1.28 MeV γ-radiation (^{60}Co-radiation) in water was calculated. The experience gained thereby and the comparison of the calculated radiation field with the calculated or experimentally determined values of other authors show that the method applied is also suited for more extensive investigations. (auth)

45302 (ORNL-tr-2353) DP-1: ALGOL PROGRAM FOR THE CALCULATION OF THE ENERGY SPECTRA OF SCATTERED GAMMA-RAYS IN A PLANE SHIELDING LAYER. Gerstel, S. A. W. (Karlsruhe Univ. (West Germany). Institut fuer Struktur der Materie). Translated for Oak Ridge National Lab., Tenn., from report BMBW-FBK-69-43. 40p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 18016.

45303 ANALYSIS OF TRANSMITTED GAMMA RAYS BY MULTIPLE SCATTERING METHOD. I. GAMMA-RAYS TRANSMITTED THROUGH SLABS OF ONE MATERIAL. Harima, Yoshiko; Nishiwaki, Yasushi (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo); 7: 407-17(Aug 1970).

Dose-buildup factors and number spectra of γ rays transmitted through a homogeneous finite slab were estimated by the multiple scattering method, taking into account scattering, including backscattering, up to the fourth order. The calculations were performed for 1.0, 3.0, 6.0, 8.0, and 10.0-MeV γ rays normally incident on lead, iron and water slabs of thicknesses from 1 to 15 mfp. The results of the above calculations are in good agreement with those from other calculations, such as by Monte Carlo and response matrix methods, especially for heavy shielding materials of practical importance and γ rays of high incident energy. Further, a method is proposed with which the contribution to the total dose buildup

factor by the γ rays of the fifth and higher orders of scattering can be estimated approximately. With this method, good agreement was obtained with the dose buildup factor calculated by the Monte Carlo method, even for light shielding materials and γ rays of low incident energy. (auth)

45304 BACK-SCATTERING OF NEUTRONS BY ALUMINUM, TITANIUM, GRAPHITE, AND POLYETHYLENE. Egorov, Yu. A.; Zharkov, V. P.; Orlov, Yu. V. At. Energ. (USSR); 28: 170-2 (Feb 1970). (In Russian).

The angular distribution of neutrons reflected by Al, Ti, graphite and polyethylene shields of "semi-infinite" thickness was measured in a water-cooled, water-moderated research reactor. A narrow directional neutron beam, incident under an angle α of 0, 20, 40, 60, and 80° was used for the measurements carried out with an isotropic noncollimated detector. The albedo was also measured in addition to the energy distribution of the reflected neutrons. In all cases at energies below 2 to 3 MeV, the spectrum of the reflected neutrons was much softer than that of the incident beam, especially in the case of polyethylene. Below about 50 keV, the reflected neutron spectra were found to lie close to the 1/E spectrum. The energy distribution of neutrons reflected by aluminum and graphite were found to be close to those reflected by titanium. The angular dependence of the integral dose albedo A of titanium is given by the formula $A(\alpha) = A_0 \cos^{\frac{1}{2}}\alpha$. In the case of polyethylene, as of water, the integral dose albedo of neutrons increases with α. (TTT)

45305 MONTE CARLO PROGRAM FOR PHOTON AND ELECTRON TRANSPORT CALCULATION. Sugiyama, Haru. Denki Shikensho Iho; 34: 126-40(Feb 1970). (In Japanese).

A general method of Monte Carlo calculations for photon and electron transport problems is explained. The main features of this program are as follows. (1) It is applicable to any energy range, especially suitable for a few to 100 MeV. (2) The shape of incident radiation spectrum can be arbitrary. Namely complex problems in treatment of bremsstrahlung x-ray are largely removed. (3) Photon and electron transport problems are treated symmetrically. Accordingly, the ratio of the total energy of backscattered photons to the total incident electron energy can be easily obtained as an example. (auth)

45306 OPTIMIZATION OF THE SHAPE OF THE SHADOW SHIELD BY USING THE MONTE CARLO METHOD. Generozov, V. L.; Sakovich, V. A. At. Energ. (USSR); 28: 175-6(Feb 1970). (In Russian).

Calculations were carried out to determine the minimum of the functional of the energy flux of γ radiation at a certain distance from the source, keeping the weight of the shield constant. The internal surface of the shadow/shield was not supposed to be closer to the source than a certain preset distance. The system was optimized by means of gradient programming. The weight of the shield was calculated from geometric relations, while the γ energy flux was obtained from Monte-Carlo calculations on the basis of the local flux. A plane shape was chosen originally for the iron shield; its thickness was calculated to attenuate 5-fold the original radiation. The study was completed in 7 iterations. (TTT)

45307 TRUNCATION ERROR ANALYSIS OF FINITE DIFFERENCE APPROXIMATIONS TO THE TRANSPORT EQUATION. Reed, Wm. H.; Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 41: 237-48(Aug 1970).

The truncation error of difference approximations to the transport equation is examined, and difference equations which are uniformly second-order accurate are derived. Resulting angular quadrature sets are shown to integrate exactly polynomials of second order in the direction cosines. The analysis is completed for the most general cases of three dimensional spherical and cylindrical geometries. Numerical results comparing this second-order scheme to the standard diamond difference equations in one-dimensional spherical geometry are presented. (auth)

45308 CALCULATIONS OF HIGH-ENERGY PHOTON BACK-SCATTERING. Sugiyama, Haruo. Denki Shikensho Iho; 34: 141-50(Feb 1970). (In Japanese).

The energy albedo was calculated by both the Monte Carlo method and simple analytical formulae based on a single scattering approximation. The calculated energy ranges are 3, 5, 8 and 10 MeV for monochromatic photons and 6, 10, 13 and 19 MeV for bremsstrahlung x rays (27 and 52 MeV also in the case of lead). The results are compared with high-energy experimental data. For copper and lead the calculated data seem to agree with Kruglov's results, but large discrepancies are found for the other results. These discrepancies are considered to be explainable after consideration that the experimental results are affected by the back-scattered electrons. (auth)

45309 METHOD FOR MODELING THE MEAN FREE PATH OF PARTICLES. Mikhailov, G. A. At. Energ. (USSR); 28: 175(Feb 1970). (In Russian).

The modeling of the mean free path of particles on the basis of the solution of the transfer equation by the Monte-Carlo method results in a simplification of the calculations. The method used by W. Coleman was further simplified and generalized. The new technique should be used only within certain ranges, applying it together with so-called "gravimetric" techniques, which are usually required to calculate the "optical" path. The mean number of collisions in the modeling of the transformed kinetic equation as derived in the calculation may be applied to concrete systems. Use of such fictive processes have already been used for modifying the Monte-Carlo technique. (TTT)

45310 ELECTRON PENETRATION OF INFINITE MEDIA. Stark, J. P. (Univ. of Texas, Austin). J. Appl. Phys.; 41: 809-10(Feb 1970).

Electron motion is studied, considering the average energy dissipation through the Bethe formula. Electron scattering then follows the solution of the Lewis transport equation. Simplification is accomplished through an expansion in spherical harmonics. The results are discussed. (M.H.R.)

45311 INVESTIGATION OF THE ANGULAR DISTRIBUTION OF NEUTRONS FROM AN ISOTROPIC SOURCE BEYOND LEAD AND IRON BARRIERS. Kiryushin, A. I.; Sukharev, Yu. P. This paper was summarized in At. Energ. (USSR); 26: 455(May 1969) as paper No. 297. (In Russian).

The Monte Carlo method was used for calculating the angular distribution of neutrons from an infinite flat isotropic source of fission neutrons beyond lead and iron barriers. The angular neutron distribution was determined by using the method of expected quantities, where the probability of neutron emergence from the layer is calculated for each scattering point, while the product of the statistical weight and the emergence probability is stored in the cells of an angular spectrum counter. The calculations were performed for fast neutrons ($E \geq 1.0$ MeV) and neutrons with an energy $E \geq 0.1$ MeV for barrier thicknesses of 5, 10, 15, and 20 cm. Analyzing the data obtained, it is found that the angular neutron distribution for $\cos\theta \geq 0.3$ (θ is the angle of neutron emergence from the barrier) is virtually isotropic for barrier thicknesses of up to 5 cm. Anistropy of the angular distribution is observed with an increase in the barrier thickness. (auth)

Solid-State Physics

Radiation Effects

Refer also to abstracts 44379, 44749, 45016, and 45392.

45312 TEMPERATURE EFFECT IN POSITRON ANNIHILATION IN SINGLE CRYSTALS. Dekhtyar, I. Ya. (Inst. of Metal Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 12: 488-9(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 636-7(Feb 1970).

It has been observed that the area under the curve for the angular correlation of the annihilation radiation increases with temperature. This may be due to a high probability of reflection by diffraction from internal faces long before the positron is thermalized, with resulting channeling and escape from the crystal. Equations are derived for this effect and estimates made for Zn. (D.L.C.)

45313 THERMAL TRANSFORMATIONS OF RADIATION DEFECTS IN LITHIUM FLUORIDE CRYSTALS. Politov, N. G.; Vorozheikina, L. F. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 277-83(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 343-50(Feb 1970).

Thermal transformation processes of radiation Frenkel defects and F centers into aggregate, quasimetallic, metallic, and atomic centers in lithium fluoride crystals were traced by optical spectroscopy. The crystals were irradiated with dosages ranging from 10^{14} to 1.5×10^{8} neutron $\cdot$ cm^{-2}. The annealing time and temperature were varied according to the irradiation dosage. A collection of quasimetallic centers emerges at the early annealing stage in crystals irradiated in a reactor with a dosage of 10^{17} neutron $\cdot$ cm^{-2} and higher. During the course of further annealing, both metallic and atomic centers form from them. It is shown that the metallic and atomic centers correspond to the absorption bands at 490 (W_2) and 275 (W_1) nm. In between these bands there are observed the W_k-absorption bands of quasimetallic centers, with the most sharply expressed band among them being the one

at 350 nm. The colloidal genesis of the W_2 band is confirmed by the results of investigation of its behavior at decreased temperature of the crystal, upon changed concentration of the hydroxyl and oxygen-containing impurities, upon varying the annealing time, and so on as well as by the agreement of its spectral position with the calculated value obtained from Doyle's theory. During the long-term annealing process, the thermal dissociation of the metallic centers is accompanied by increased concentration of atomic centers. Aggregates of atomic centers with the W_1 band at 295 nm are first formed upon the breakup of the metallic centers, which then decompose and form simple atomic centers with the W_1 band at 270 to 275 nm. It was determined that the quasi-metallic and the metallic centers become coarser upon injection into the crystals of electrons (β decomposition of tritium, optical destruction of the F centers). The emergence of metallic centers was confirmed by EPR spectra and by electron microscopy. (auth)

45314 INTERPRETATION OF CHANNELED-ION BEAM MEASUREMENTS FOR FOREIGN ATOM LOCATION IN CYRSTALS. Alexander, R. B. (Clarendon Lab., Oxford); Dearnaley, G.; Morgan, D. V.; Poate, J. M. Phys. Lett.; 32A: 365-6(10 Aug 1970).

The assumptions generally made in the interpretation of channelling experiments for atom location have been examined. Computer simulations show that the interaction yield from interstitial foreign atoms may be up to four times as large for a channelled as for a random beam. (auth)

45315 PARAMAGNETIC RELAXATION IN RADIATIVE LITHIUM COLLOIDS. Vitol, A. Ya.; Shvarts, K. K.; Ekmanis, Yu. A. (Inst. of Physics, Riga). Sov. Phys.-Solid State (Engl. Transl.); 12: 378-80(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 487-91(Feb 1970).

Radiative lithium colloids are investigated by EPR and electron microscopy in reactor-irradiated LiF crystals. It is shown that an EPR line of width $\Delta H \gtrsim 50$ G corresponds to the lithium colloids. For colloids with diameters $D < 1$ to 2 μ, surface relaxation is a highly effective line-broadening mechanism. The values found for the probability of spin flip on the surface and the spin–lattice relaxation time are $\epsilon = 10^{-4}$ and $T_1 = 10^6$ sec, respectively. (auth)

45316 LOW-TEMPERATURE THERMAL CONDUCTIVITY STUDIES ON SILICON IRRADIATED WITH FAST NEUTRONS AT 80°K. Seyfert, P. (CENG, Grenoble, France). J. Low Temp. Phys.; 2: 555-71(Jun 1970).

Experimental results are presented concerning low-temperature (2 to 200°K) thermal conductivity measurements of silicon irradiated with fast neutrons between 10^{16} and 6×10^{17} n/cm^2, and low-temperature annealing studies. The effects are intrinsic and are mainly due to the heterogeneous defect structure. A simple model of this defect structure explains the phonon scattering that determines the thermal conduction below 20°K. The relaxation-time expression used takes into account the volume distribution of the disordered regions and their "opacity" as it is seen by phonons. Low-temperature annealing does not affect the volume distribution, but causes the "opacity" to decrease. (auth)

45317 EFFECT OF ELECTRON BOMBARDMENT ON FINE STRUCTURE OF PHOTOCONDUCTIVITY CURVES IN CdS CRYSTALS. Grigor'ev, R. V.; Novikov, B. V. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 81-6(Nov 1969). (In Russian).

Cadmium–sulfide crystals were exposed to 3- or 45-keV electron beams, and considerable changes in spectral distribution of photoconductivity were observed. Fine structure is shown to be greatly dependent on atmosphere surroundings because of the adsorption on the crystal surface. A mechanism for the effects of the absorbed oxygen on CdS photoconductivity is discussed. (auth)

45318 ANISOTROPY OF PARAMAGNETIC Y CENTERS IN LiF CRYSTALS. Davitashvili, T. Sh.; Dzhordzhishvili, L. I.; Kalabegishvili, T. L.; Politov, N. G.; Sobolevskaya, S. V. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 234-5(Jul 1970).

Translated from Fiz. Tverd. Tela; 12: 289-91(Jan 1970).

The Y line, a narrow structureless line in the EPR spectrum of irradiated LiF crystals, was isolated by nonisothermal annealing of the crystals. The width ΔH and g factor of the Y line were measured as a function of crystal orientation relative to the magnetic field. The results show that the Y centers have an axis of axial symmetry along the ⟨111⟩ axis. It is felt that the Y line arises from clusters of F centers. (D.L.C.)

45319 DISLOCATION PINNING RATE IN ELECTRON-IRRADIATED COPPER. Roth, G.; Sokolowski, G.; Luecke, K. (Technische Hochschule, Aachen. Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi: 40: K77-80(1 Aug 1970).

Damping and modulus measurements were made on polycrystalline Cu after irradiation with 3-MeV electrons at different temperatures. The results, which show a minimum in the pinning rate from damping at ~160°K but not in the pinning rate from modulus, are compared with those of Thompson and Buck (Phys. Status Solidi; 37, 53 (1970)) for gamma-irradiated single-crystal Cu. (D.L.C.)

45320 KOHLER RULE OF HALL COEFFICIENT IN NEUTRON-IRRADIATED ALUMINIUM AT 4.6°K. Boening, K.; Fenzl, H. J.; Welter, J. M.; Wenzl, H. (Technische Hochschule, Munich). Phys. Status Solidi; 40: 609-22(1 Aug 1970).

An investigation is made of the range of validity of the Kohler rule for the Hall coefficient of aluminum at 4.6°K, by introducing structural defects with different concentration and configuration by low-temperature reactor irradiation and subsequent annealing. During irradiation, the low-field Hall coefficient R_0 at first increases rapidly and even changes its sign. But as soon as the electron scattering is predominantly governed by the radioinduced defects, the Hall coefficient R_0 (being now slightly positive) remains constant during further irradiation and the Kohler rule is fulfilled, because then only the concentration of identical defects is enlarged. After step-annealing again large changes of R_0 occur, because the structural defects not only recombine but also rearrange to other configurations with different scattering behavior. (auth)

45321 SIMPLIFIED TECHNIQUE FOR CRYSTAL ALIGNMENT DURING CHANNELING EFFECT MEASUREMENTS. Borders, J. A.; Picraux, S. T. (Sandia Labs., Albuquerque, N. Mex.). Rev. Sci. Instrum.; 41: 1230-1(Aug 1970).

A system using a goniometer, radiation detector, and a multichannel pulse height analyzer in the multiscale mode is described for crystal alignment during ion channeling studies. Backscattered protons are detected with a surface-barrier detector. (W.H.K.)

45322 ENHANCED DIFFUSION AND OUT-DIFFUSION IN ION-IMPLANTED SILICON. Meyer, O.; Mayer, J. W. (California Inst. of Tech., Pasadena). J. Appl. Phys.; 41: 4166-74 (Sep 1970).

Backscattering and channeling-effect measurements were used to determine the lattice disorder and distribution, lattice location, and diffusion of species (Rb, Cs, Zn, Cd, Hg, Se, I, and Sb) implanted in Si. During anneal sequences the following were observed: (1) enhanced diffusion towards the surface (Sb, Se, and Cd), (2) retardation or precipitation at the surface (Sb, Se, and Cd), and (3) a connection between out-diffusion and reordering of the amorphous layer (Zn, Cd, Hg, and I). The data also suggest that release of atoms from trapping (precipitation) sites in the implanted layer can be the rate-limiting process in some cases. These results indicate that out-diffusion studies such as gas release, may not represent bulk diffusion properties in crystals. (auth)

45323 NATURE OF X CENTRES IN NaCl CRYSTALS WITH ANIONIC IMPURITIES. Tsal, N. A.; Didyk, R. I. (Lvov State Univ.). Phys. Status Solidi; 40: 409-16(1 Jul 1970).

The effects of heat treatment and light on the conversion of F into X centers were investigated in specially treated NaCl crystals with hydroxyl impurities. The mechanism of the stimulating action of the impurity in the $F \rightarrow X$ conversion is analyzed. The results of the work are treated from a viewpoint of a new model of X centers, according to which these centers are "quasi-colloidal" formations, occurring at the initial stage of F-center coagulation. Suggestions are presented about the mechanism of a direct formation of quasi-colloidal centers (X centers) in crystals under high-dose γ irradiation. (auth)

45324 EXOELECTRON EMISSION FROM THIN FILMS OF ALKALI METAL HALIDES. Sendecki, S. (Wroclaw Univ.). Acta Phys. Pol.; A38: 49-55(1970).

Photostimulated emission of electrons from thin films of NaCl, KCl, KBr, and KI excited by irradiation with x rays was studied. The films were deposited by means of the vacuum evaporation method at various deposition rates. The influence of the deposition rate and the intensity of stimulating light on the initial intensity of emission as well as on emission decay rate were investigated. The existence of a maximum value of the decay constant at a certain deposition rate was found in case of NaCl and KCl films. The dependence of the initial intensity of emission on the deposition rate also exhibits a disturbance of the monotone behavior at this particular deposition rate. (auth)

45325 PERMEABILITY AND DISACCOMMODATION IN IRRADIATED Fe–Al ALLOYS OF LOW Al CONCENTRATIONS. Steinert, J. (Zentralinstitut fuer Festkoerperphysik und

Werkstofforschung, Berlin). Phys. Status Solidi; 40: K37-9 (1 Jul 1970).

The magnetic permeability μ and the disaccommodation $D = [\mu(o) - \mu(t)]/\mu(t)$ (for an alternating field of 10 mOe at 50 Hz and t = time passed after last demagnetization) were measured as a function of temperature for a Fe–6 at. % Al alloy after irradiation with 3.7×10^{17} fast neutrons/cm^2. μ was found to be lower in irradiated samples than in annealed samples below 550°C. Of the D spectrum containing five peaks, only the high-temperature peak is found in unirradiated alloys. The other peaks increase strongly with Al content, so that alloys with 12 and 20 at.% Al are impossible to demagnetize with a field of 3 Oe. (D.L.C.)

45326 RADIATION COLLOIDAL CENTERS IN ALKALI HALIDE CRYSTALS. Kristapson, Ya. Zh. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 1, 34-9(1970). (In Russian).

Formation of colloidal color centers in the crystals at large radiation doses is investigated. In KCl, NaCl, and KBr crystals, activated by Ag, Tl, or Cu, the formation of impurity colloidal centers was found. Absorption spectra of the irradiated crystals are compared with calculations according to Mie's formulas. (auth)

45327 COULOMB INTERACTION IN THE RADIATION CREATION OF KCl:Tl COLOR CENTERS. Aluker, E. D.; Aksenov, O. E.; Romanenko, N. L. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 1, 78-83(1970). (In Russian).

It has been assumed that the Coulomb interaction of charged color centers with electrons and holes may result in the existence of maximum concentration of such centers in the crystals. Data on KCl–Tl coloring at 77°K confirming this assumption are presented. A method for evaluating the charge carriers energy localized on the capture centers is suggested. The application of the method to KCl presents a proof that the autolocalization of the holes with energy >0.054 eV is excluded. The value of $E^m = 0.054$ eV is considered the depth of the potential well which represents itself as an anion point of a regular lattice for a hole. (auth)

45328 DOUBLE BRAGG REFLECTION IN NEUTRON-IRRADIATED LITHIUM FLUORIDE SINGLE CRYSTALS. Telegina, I. V.; Kolontsova, E. V. (Moscow State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 15: 162-3(Jul-Aug 1970).
Translated from Kristallografiya; 15: 195-6(Jan-Feb 1970).

Double Bragg reflection was examined in LiF monocrystals after irradiation with 10^{19} n/cm^2. The intensity distribution in the double-Bragg streaks differs from that in true small-angle scattering; thus, the two effects may be distinguished. The double-Bragg reflection vanishes when the crystal is rotated through an angle equal to the total angle of fragment disorientation. The required steps in establishing the presence of true anisotropic scattering are described. (D.L.C.)

45329 EFFECT OF IONIZING RADIATION AND Sr^{2+} CONCENTRATION ON HARDENING OF KCl CRYSTALS. Suszynska, M. (Inst. of Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (a): 2: 635-41 (16 Jul 1970).

The hardening of KCl crystals induced by ionizing radiation or Sr^{2+} admixture (9 to 1000 ppm) is examined by measuring the size of patterns revealed around indentation by the etching method or by decoration with F centers. A characteristic change of hardening efficiency observed above 200 ppm Sr^{2+} is probably related with a change in the distribution mode of impurity ions in the host crystal. With increasing Sr^{2+} concentration, the number of subgrain boundaries increases while the density of isolated dislocations significantly decreases. The effectiveness of radiation in the hardening of pure crystals is higher than for Sr^{2+} ions. (auth)

45330 CHANGE OF CONDUCTIVITY IN AMORPHOUS DE-LENIUM FILMS BY ELECTRON BOMBARDMENT (10 TO 100 keV). Reimer, L.; Senss, J. (Univ., Muenster, Ger.). Phys. Status Solidi (a); 2: 809-16(16 Aug 1970).

Measurements of the change of conductivity caused by electron bombardment in selenium films with a thickness of 1 to 16 μm are reported. The bombardment electrons had an energy of 10 to 100 keV. A theoretical explanation of the experimental results is attempted, using a simple model of an ionization chamber. Optimal results are received, if the range of the bombardment electrons is equal to the thickness of the Se layer. (auth)

45331 ENERGY OF RADIATION DEFECT CLUSTERS IN NEUTRON-IRRADIATED COPPER. Pedchenko, K. S.; Karasev, V. S. (Inst. of Physics, Kiev). Phys. Status Solidi (a); 2: K263-7(16 Aug 1970).

A comparison is made between the stored energy values computed with various assumptions of the nature of the defect centers, with the experimental value for fast neutron-irradiated Cu. The assumptions were: spherical voids, perfect dislocation loops, Frank dislocation loops, and stacking-fault tetrahedra. The fast neutron dose for which calculations and measurements were carried out was 4×10^{18} n/cm^2. The energy is released in two stages, and the fraction of the released stored energy due to clusters is dose-dependent. The comparison shows that the clusters consist in part of spherical and in part of flat formations. (D.L.C.)

45332 ELECTRON IRRADIATION AND TRAPPING CENTRES IN ZINC SULPHIDE SINGLE CRYSTALS. Bryant, F. J.; Hamid, S. A. (Univ. of Hull, Eng.). Phys. Status Solidi (a); 2: 597-605(16 Jul 1970).

Electron radiation damage of zinc sulfide crystals at room temperature showed the creation above different threshold electron energies of two trapping states with glow peaks at 195 and 235°K. The variation with incident electron energy of the theoretically evaluated numbers of displaced primary atoms for various displacement threshold energies was correlated with experimentally induced and determined point defect concentrations (the thermoluminescence intensity enhancement) and used to give a precise value of the threshold energy for primary atomic displacement. The experimental enhancement of the 195°K glow peak yielded a sulfur displacement threshold energy of 15.4 ± 0.5 eV (corresponding to an incident electron energy of 190 ± 5 keV). The experimental enhancement of the 235°K glow peak was used to determine the zinc displacement threshold energy of 9.7 ± 0.2 eV (an incident electron energy of 235 ± 5 keV). The isochronal and isothermal annealing characteristics of the glow peaks were also determined. (auth)

45333 PRODUCTION AND ANNEALING OF DEFECTS IN ELECTRON IRRADIATED LEAD. Papastaikoudis, C.; Ullmaier, H.; Kernohan, R. H. (Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi (a); 2: K171-4(16 Jul 1970).

Lead foils were irradiated with 3-MeV electrons at 4.6°K and the electrical resistivity increase used as a measure of Frenkel defect density. The linear decrease predicted by theory was observed, except at low doses. Isochronal annealing showed stages similar to these for other fcc metals, except that they occurred at higher temperatures (170°K for I_D stage). (D.L.C.)

45334 THRESHOLD AND PRODUCTION OF LENGTH CHANGE INTRODUCED INTO PURE AND DOPED MgO WITH ELECTRON IRRADIATION BELOW 90°K. Sickles, James Edward. Evanston, Ill.; Northwestern Univ. (1969). 96p. University Microfilms Order No. 70-6532.
Thesis.

An attempt was made to improve the understanding of the damage mechanism in MgO and to verify, if possible, by making sensitive length change production measurements after bombardment by 0.30- to 2.0-MeV electrons in the temperature range 15 to 90°K, that elastic collisions are the predominate damage mechanism in MgO. A new technique for making sensitive length change measurements in insulators at cryogenic temperatures was employed. The length changes were measured with a specially designed, temperature-compensated, capacitor using the 3-terminal capacitance method for measuring small capacitance changes. The sensitivity of the method was 0.6 Å or 1.2×10^{-8} per unit length. Thin "pure" MgO specimens, bombarded with low-energy electrons, were observed to contract until a saturation contraction was reached at low dose (<5.0×10^{16} electrons/-cm^2). At incident electron energies greater than 0.375 MeV (transition energy) the specimens expanded. The expansion production rate was found to increase with incident electron energy. Production measurements made at 1.6 MeV indicate that the expansion approaches saturation at a dose of about 5×10^{17} electrons/cm^2 resulting in a total length change (~0.2%) which is approximately 20 times larger than the saturation contraction produced at energies below the transition energy. Evidence is presented which correlates the contraction observed below the transition energy with the production of V_i centers, positive-ion vacancies with trapped holes, and the expansion produced at higher energies with the production of F-type centers, negative ion vacancies with one or more trapped electrons, which have been observed in optical absorption studies of electron-irradiated MgO. As a result of this correlation, the sharp transition energy is identified with a 70-eV threshold energy for displacement of oxygen ions in MgO. It was, therefore, concluded that the primary damage mechanism in MgO is one of elastic collisions, thereby giving additional support to the idea that crystal bonding is significant in determining radiation damage in a material. Additional threshold and production data are presented for MgO doped with Fe, Co, and Cr, and for "pure" specimens subjected to various pretreatments, such as heat treatment at

1200°C and gamma irradiation, prior to electron irradiations. Gamma ray production results in MgO are also reported. Some low-temperature length-change annealing data were obtained using the "constant rate of warming" method, which indicates that a small amount of electron damage recovery may take place in MgO in the temperature range 55 to 75°K. (Diss. Abstr. Int., B)

45335 X-RAY-INDUCED VOLUME EXPANSION IN KBr AT LOW TEMPERATURES. Farnum, Eugene Howard. Princeton, N. J.; Princeton Univ. (1968). 131p. University Microfilms Order No. 70-5935.

Thesis.

Results are reported of experiments that measured for the first time the relaxations occurring around defects induced by x rays in KBr at temperatures between 5 and 80°K. A sensitive capacitive dilatometer was developed and used to measure the volume expansion. The number of defects was determined from the optical absorption spectrum between 1700 and 190 nm. Temperatures between 11 and 20°K were chosen to coincide with annealing stages of the α center previously reported (Phys. Rev., 137: A1010(1965)). The results at 5°K agree well with values obtained from calculations based on the simple models which are believed to represent the products of radiation damage at that temperature. While at 30°K, the charged interstitial is about the same size as that found at 5°K, the relaxations measured for this interstitial formed between 11 and 20°K are about twice as large as those formed at 5°K. Measurements made at 78°K agree very well with measurements made at that temperature by other investigators with different experimental methods. It is proposed that the size of the (α + I) defect pair is reduced at 5°K because the defects are so close that their overlapping strain fields partially cancel, and at 30°K because the interstitial is stabilized by a nearby impurity. The large size observed at intermediate temperatures is believed to be caused by the relaxation around well-separated vacancies and interstitials. Evidence for the existence of two types of interstitial defects is found in optical bleaching studies of the F center which can be decreased with no change in the volume expansion. Two new optical absorption bands were found between the α band at 201 nm and the I band at 230 nm. It is possible that these poorly resolved bands, like the I band, are caused by exciton transitions near interstitials, but are not shifted as far as the I band because the interstitial, in these cases, interacts more strongly with a nearby vacancy. (Diss. Abstr. Int., B)

45336 X-RAY TOPOGRAPHIC OBSERVATION OF RADIATION DAMAGE IN TGS SINGLE CRYSTALS. Polcarova, M. (Inst. of Physics, Prague); Bradler, J.; Janta, J. Phys. Status Solidi (a); 2: K137-9(16 Jul 1970).

X-ray topographs were made after each of three successive x irradiations of triglycine sulfate single crystals. A cylindrical collimator was used in the first two irradiations, but omitted in the third. The collimated irradiation results in an enhanced blackening, evidence of inhomogeneous lattice distortion. Domain structure was revealed by etching. It is concluded that homogeneous x irradiation is followed by homogeneous lattice distortion, and that contrast on x-ray topographs is formed only in places of inhomogeneous irradiation, e.g., at interfaces. (D.L.C.)

45337 RADIO-OPTICAL PHENOMENA IN CaF_2-REF_3 CRYSTALS. Vakhidov, Sh. A.; Kaipov, B.; Tavshunskii, G. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 73-7(1970). (In Russian).

Data obtained on γ-induced luminescence of CaF_2-ErF_3 and CaF_2-HoF_3 crystals in a ^{60}Co γ-ray field (dose = 100 r/sec) showed that, at 77°K, new lines appeared in the spectrum whose intensities diminished with temperature. At 340°K, the new lines disappeared completely and only the lines of the tetragonal center (which are, also, observed in the photoluminescence spectrum) remained. (R.V.J.)

45338 MINORITY CARRIER LIFETIME IN ION-IMPLANTED AND ANNEALED SILICON. Davies, D. Eirug; Roosild, S. A. (Air Force Cambridge Research Labs., Bedford, Mass.). Appl. Phys. Lett.; 17: 107-9(1 Aug 1970).

Results are presented of an investigation to determine whether minority carrier lifetime within ion-implanted layers can be restored to preirradiation levels by annealing. Reverse-recovery measurements were conducted on diffused diodes damaged on the low-doped side by light doses of carbon. The results show that practically complete recovery can be obtained, but annealing beyond the 400°C range associated with light-dose lattice reordering to as high as 600 to 650°C is required. (auth)

45339 VARIATION OF THE PLANAR BLOCKING WITH THE POSITION OF EMITTING ATOMS. Komaki, K.; Fujimoto, F. (Tokyo Univ.). Phys. Status Solidi (a); 2: 875-83(16 Aug 1970).

The angular distribution and dip area of the planar blocking due to charged particles emerged from a crystal are calculated. The derived formulas are applied to the cases where the emitting atom is not on lattice plane and the compound nucleus is formed. The results show that the change of dip area is very sensitive to displacement of emitting atom from the lattice plane. The yield of the channeling part in the blocking pattern is also calculated. Numerical examples of angular distribution for various positions of the emitting atom are given for the {111} planar blocking of protons in germanium. (auth)

Physical Properties

Refer also to abstracts 44693, 44774, 44802, 44830, 44980, 45010, 45011, 45056, 45192, and 45722.

45340 ADSORPTION AND WORK FUNCTION OF YTTERBIUM AND NEODYMIUM ON TUNGSTEN. Marinova, Ts. S.; Zubenko, Yu. V. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 12: 398-400(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 516-19(Feb 1970).

The effects of ytterbium and neodymium adsorption on the electron emission from tungsten were studied in a field emission microscope. Minimum work functions of 2.5 and 2.7 eV, respectively, were observed for the film systems Yb–W and Nd–W at a pressure of 10^{-9} torr. The work function limiting value of these systems for thicknesses greater than two monolayers was taken to be the adsorbate work function. Values of φ_{Yb} = 2.6 ± 0.05 eV and φ_{Nd} = 3.1 ± 0.05 eV were obtained for ytterbium and neodymium, respectively. (auth)

45341 MIGRATION AND EVAPORATION OF YTTERBIUM AND NEODYMIUM ON TUNGSTEN. Marinova, Ts. S.; Zubenko, Yu. V. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 12: 401-3(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 520-5(Feb 1970).

Surface diffusion (migration) and thermal desorption of ytterbium and neodymium atoms on tungsten were studied with a field-emission microscope. The migration activation energy of ytterbium was Q_m = 0.45 ± 0.05 eV from the {011} to the {100} face and Q_m = 0.70 ± 0.05 eV along the {121} face. For neodymium, the migration activation energy is Q_m = 0.75 ± 0.05 eV in the direction from the {101} to the {100} face and Q_m = 0.65 ± 0.05 eV along the {111} face. The heat of desorption of ytterbium from tungsten is Q_d = 2.2 eV, and the rate factor $C = 5 \times 10^{13}$ sec^{-1}. For neodymium at the initial stage of desorption of a monatomic layer, Q_d = 3.3 eV and $C = 2 \times 10^{12}$ sec^{-1}, and for a rarefied layer Q_d = 4.5 eV and $C = 7 \times 10^{13}$ sec^{-1}. (auth)

45342 MIGRATION OF Tl ON TUNGSTEN IN STRONG ELECTRIC FIELDS. Vladimirov, G. G.; Medvedev, B. K.; Sokol'skaya, I. L. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 12: 413-16(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 539-44(Feb 1970).

A field emission microscope was used to study the effect of a strong electric field F on the surface-diffusion activation energy Q of titanium on tungsten in the direction (011) → (121) at various adsorbate concentrations θ. As a unit coating (θ = 1) an equilibrium concentration was taken at which the system work function averaged over the entire tip becomes constant and equal to 3.6 eV. It was found that at $\theta \leq 0.7$, Q is a linear function of the external field. As the amount of adsorbate is further increased, the Q(F) curve acquires the form of a parabola slightly displaced in the direction of positive fields. The obtained results can be explained in terms of p_{ef} and α_{ef}. The quantity p_{ef} so defined decreases from +3.4D at θ = 0.2 to zero at θ = 0.7, and becomes negative as the coating is further increased (i.e., the plus of the dipole points to the substrate). The value of α_{ef} was found equal to 10^{-23} cm^3. It was found that there exists a correlation between the field dependence of log D_θ, where D_θ is the diffusion constant, and the behavior of Q(F). (auth)

45343 TWO-BAND ELECTRON–PHONON INTERACTION IN RHENIUM. Robinson, D. A.; Levy, M. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 24: 1238-42(1 Jun 1970).

Anomalies were observed in the electronic component of the ultrasonic attenuation of transverse and longitudinal waves in high-purity rhenium, which could not satisfactorily be explained by the free-electron or real-metal theories of Pippard. A two-band model is developed to explain the observed attenuation. (auth)

45344 STRUCTURE AND ADSORPTION BEHAVIOR OF SODIUM FILMS ON (011) FACES OF TUNGSTEN. Medvedev, V. K.; Naumovets, A. G.; Fedorus, A. G. (Inst. of Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 12: 301-6(Aug 1970).

Translated from Fiz. Tverd. Tela; 12: 375-85(Feb 1970).

Slow-electron diffraction was applied to the structure of sodium films adsorbed on (011) faces of tungsten at 77 to 400°K. A series of structures of adsorbed films are observed at certain concentrations, and order–disorder transitions are studied in these structures. The results are compared with measurements of the contact potential, work function, and heat of adsorption as functions of concentration on (011) faces. Disruption of long-range order in monatomic films of sodium is not accompanied by an appreciable change in the work function. It is concluded that adsorbed sodium atoms on (011) faces of tungsten repel one another. (auth)

45345 QUANTUM THEORY OF ELECTRON–OPTICAL PHONON INTERACTION IN IONIC CRYSTAL FILMS. Lucas, A. A. (Univ. of Liege); Kartheuser, E.; Badro, R. G. Solid State Commun.; 8: 1075-9(1 Jul 1970).

A quantum-mechanical treatment is developed for the interaction of an electron with optical phonons of an ionic crystal film. When applied to the case of a fast electron, the electron energy loss and gain spectra are obtained and agree well with the experimental data on LiF. The gain spectrum is obtained for the first time and shows the observed strong temperature-dependence. Losses through multi-phonon processes occur in the LO phonon energy range. (auth) (UK)

45346 NONSTRUCTURAL ESTIMATE OF THE ORBITAL SHIELDING OF METALLIC NUCLEI. Smith, T. B. (Univ. of Bristol, Eng.). J. Phys., C (London); 3: 1159-65(May 1970).

The model used is that of a nucleus at the center of a single spherically symmetric potential, immersed in an otherwise-free electron gas. The analytic result for the shielding constant has a rather simple form. An approximation leads to a simple relation between the orbital shielding constant and the orbital susceptibility; however, exact calculations for several metals of the paramagnetic van Vleck contribution using a muffin-tin potential proved easy. The results indicate that in indium, at least, the orbital contributions are not small. (auth) (UK)

45347 CRYSTAL FIELDS AND THE MAGNETIC PROPERTIES OF PRASEODYMIUM AND NEODYMIUM. Johansson, T. (Technical Univ., Lyngby, Denmark); Lebech, B.; Nielsen, M.; Moeller, H. Bjerrum; Mackintosh, A. R. Phys. Rev. Lett.; 25: 524-6(24 Aug 1970).

The magnetic properties of Pr and Nd single crystals were studied by neutron-diffraction and susceptibility measurements. In contrast to earlier results on polycrystals, monocrystalline Pr is found not to be magnetically ordered, because of crystal field effects, but a magnetic field induces a large moment. Anisotropic effective exchange results in a large magnetic anisotropy. The complex magnetic structure of Nd is substantially modified by a magnetic field. (auth)

45348 MAGNETIC PROPERTIES OF URANIUM TETRACHLORIDE AND OF CHLOROURANATES(IV) IN THE SOLID AND FUSED STATE. Trzebiatowski, W.; Mulak, J. (Inst. of Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 18: 121-6(1970).

The magnetic susceptibilities and moments of UCl_4 and its compounds with the alkali metal halides (LiCl, NaCl, KCl, RbCl, CsCl) were measured at 84 to 1200°K by the Faraday method. All the compounds follow the Curie–Weiss law in the molten state. In the solid state, the compounds may be arranged into the following classes: (1) UCl_4, $MeUCl_5$, MeU_2Cl_9, and MeU_3Cl_{13}; (2) Me_2UCl_6 and Cs_3UCl_7; and (3) $Me_3U_2Cl_{11}$. Only the first class follows the Curie–Weiss law. Class (2) shows temperature-independent paramagnetic susceptibilities. The susceptibility of class (3) changes with temperature in an intermediate manner between the first and second class. The results for the molten state indicate that two kinds of ions exist with coordination numbers of 6 and 8. (D.L.C.)

45349 HALL COEFFICIENT AND ELECTRICAL RESISTIVITY OF LIQUID URANIUM. Busch, G.; Guentherodt, H.-J.; Kuenzi, H. U. (Laboratorium fuer Festkoerperphysik Zurich). Phys. Lett., 32A: 376-7(24 Aug 1970).

The Hall coefficient and the electrical resistivity of uranium were measured in the liquid and in the solid state. A positive and temperature-independent Hall coefficient was below and above the melting point over a large temperature range. The results are in good agreement with available data for the solid state at lower temperatures. (auth)

45350 NONLINEAR EXTREME QUANTUM LIMIT RESISTIVITY IN GRAPHITE. Woollam, J. A. (Lewis Research Center, Cleveland). Phys. Lett., 32A: 371-2(24 Aug 1970).

Contrary to previous experiments, it is found that the magnetoresistance above 8 tesla (80 kG) in graphite is not linear in magnetic field. The Hall and magnetoconductivities to 15 tesla are also studied. (auth)

45351 ION BEAM SCATTERING APPLIED TO CRYSTALLOGRAPHY. Barrett, C. S. (Univ. of Chicago). Naturwissenschaften; 57: 287-95(Jun 1970).

Types of information that can be derived from patterns of ion-beam scattering by crystals are reviewed. The processes of channeling and blocking are summarized briefly. Uses of ion beams in studies of impurity identification and location (interstitial or substitutional), surface damage from radiation or ion implantation, crystal structure, and phase identification are discussed. It is concluded that scattering patterns contain valuable crystallographic information on conditions existing within about 10^{-4} cm of the surface of single crystals, but in general the standard methods of x-ray, electron, and neutron diffraction yield more information and are applicable to a wider range of problems and samples. (A.G.W.)

45352 SECOND AND FOURTH ORDER SPIN–LATTICE COEFFICIENTS FOR Gd^{3+} IN THORIA. Oseroff, S. B.; Calvo, R.; Fainstein, C. (Univ. Nacional de Cuyo, Bariloche, Argentina). Phys. Lett., 32A: 393-4(24 Aug 1970).

The EPR line shifts for Gd^{3+}: ThO_2 under uniaxial stress were measured. Values are given for the second- and fourth-order spin–lattice strain coefficients. (auth)

45353 EFFECT OF STRONG PULSED MAGNETIC FIELDS ON MAGNETIC TRANSITIONS IN Mn_3B_4. Fakidov, I. G.; Timoshchuk, V. I. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 218-20(Jul 1970).
Translated from Fiz. Tverd. Tela; 12: 273-6(Jan 1970).

The dependence of magnetic-transition temperatures of the antiferromagnetic compound Mn_3B_4 upon the intensity of external magnetic fields has been determined from the magnetic susceptibility and magnetization intensity measured with a pulsed magnetic balance. The experimental results are used to plot a magnetic phase diagram. (auth)

45354 SUBDIVISION OF THE BCC TRANSITION METALS. Chen, C. W. (Ames Lab., Iowa). Phys. Status Solidi; 40: 717-24(1 Aug 1970).

Bcc transition metals are shown to display large, systematic changes in many basic physical properties on going from vanadium to chromium or iron, from niobium to molybdenum, and from tantalum to tungsten. These property changes are attributed, at least partially, to the differences in the electronic structure and nuclear composition between the group V (V, Nb, and Ta) and group VI metals (Cr, Mo, and W) and iron. A subdivision of the bcc transition metals is thus proposed. Conditions under which the metals may sensibly be considered as an undivided group are discussed. (auth)

45355 STRUCTURE AND ELECTRICAL PROPERTIES OF SPUTTERED FILMS OF HAFNIUM AND HAFNIUM COMPOUNDS. Smith, F. T. J. (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys.; 41: 4227-31(Sep 1970).

The electrical properties of 2000 to 3000-Å-thick films of hafnium, hafnium nitrides, and hafnium dioxide were studied. The properties of these films can be related to film structure and composition. Conditions were established under which hafnium films can be prepared by dc sputtering in pure argon with density and resistivity approaching that of pure bulk hafnium. Additions of low concentrations of nitrogen to the argon sputtering atmosphere result in the deposition of films consisting of a solid solution of nitrogen in hafnium. At intermediate nitrogen concentrations, films of HfN, a compound with metallic properties, are obtained. Higher nitrogen concentrations in the sputtering atmosphere result in films of nonstoichiometric HfN containing excess nitrogen and finally of films of a higher nitride of hafnium having semiconducting properties. Sputtering in argon–oxygen mixtures above a critical oxygen concentration results in the deposition of HfO_2 films with insulating properties. (auth)

45356 SPECIFIC HEATS OF EuSe AND SOME DILUTE In–Sn ALLOYS DOWN TO 0.5°K. White, Henry W. Riverside, Calif.; Univ. of California (1969). 192p. University Microfilms Order No. 70-6374.
Thesis.

Specific heat measurements were made on polycrystalline samples of the weakly antiferromagnetic compound EuSe from 0.5 to 20°K and on five dilute In–Sn alloys from 0.5 to 1.7°K in both the normal and superconducting states. EuSe has a Neel temperature near 4.5°K. The measurements on EuSe were ini-

tiated to see if any bumps could be found in the specific heat of pure EuSe below 4°K which might be associated with a proposed transition near 3°K to a state with a partially ferromagnetic spin structure. A sharp peak in the specific heat was found at T_N = 4.55 ± .01°K for the purest sample. Peak shape and location were very dependent upon sample purity. The purest samples also showed bumps at 1.7°K and 2.8°K. The entropies under the bumps were 0.11 and 0.06 J/mole-°K, respectively. Below 1°K, the magnetic specific heat could be described by $C_M = 1.44\ T^2$ J/mole-°K. The total magnetic entropy was found to be 17 J/mole-°K and the Debye temperature was determined to be 176 ± 9°K. The primary interest in the In–Sn alloy measurements was to determine the variation in the electronic density of states with Sn composition by investigating the changes in the electronic contribution, γT, to the normal state specific heat, C_n. The data were fit to the form, $(C_n - \alpha/T^2) = \gamma T + \beta T^3 + \delta T^5$, using a least squares technique. Expressing C_n in units of mJ/mole-°K, α = .001 was assumed on the basis of earlier specific heat and nuclear quadrupole resonance measurements and $(C_n - .001/T^2)$ for 0, 0.82, 2.09, 4.91, and 9.83 atomic per cent Sn was found to be $1.65\ T + 1.37\ T^3 + 0.65\ T^5$, $1.65\ T + 1.37\ T^3 + .055\ T^5$, $1.74\ T + 1.35\ T^3 + 0.65\ T^5$, $1.88 + 1.32\ T^3 + .076\ T^5$, and $1.92\ T + 1.42\ T^3 + 0.70\ T^5$, respectively. A rapid increase in γ above 1 at.% Sn is interpreted as arising from the filling of the third-zone α-arms beginning at 0.8 ± .6 at.% Sn. The superconducting-state electronic specific heat, C_{es}, was graphically fit to the BCS equation $C_{es} = A \exp(-B/T)$ and the values of A and B for each of the alloys were determined. (Diss. Abstr. Int., B)

45357 MAGNETIC PROPERTIES OF SOME CUBIC RARE-EARTH–IRON COMPOUNDS OF THE TYPE RFe_2 AND $R_xY_{1-x}Fe_2$. Buschow, K. H. J.; van Stapele, R. P. (Philips Research Labs., Eindhoven, Netherlands). J. Appl. Phys.; 41: 4066-9 (Sep 1970).

Magnetic measurements in fields up to 30 kOe and for temperatures between 4.2 and 1000°K were performed for cubic Laves phase compounds RFe_2 (R = Gd, Tb, Dy, Ho, Er, and Y) and $R_xY_{1-x}Fe_2$ (R = Gd, Tb, and Er). The Curie temperatures and saturation moments at 4.2°K are given. A compensation in the temperature dependence of the magnetization is only observed for the various compounds in a certain range of x values. Conditions for the occurrence of a compensation point are derived. For the compounds $R_xY_{1-x}Fe_2$, the iron moment remains constant for $0 \leq x \leq 0.8$. Above x = 0.8, the iron moment increases strongly. The variation of the Fe moments with x is discussed in terms of a nonlocalized moment associated with the iron ions. The moments shown by Er and Tb in $ErFe_2$ and $TbFe_2$ are both 8.3 μ_B. For most of the compounds RFe_2, the lattice constants are given. (auth)

45358 RESISTANCE MINIMA IN ZIRCONIUM–PLUTONIUM ALLOYS. Elliott, R. O.; Hill, H. H. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals; 22: 123-6(Sep 1970).

Resistance minima (Kondo effect) were investigated at 1 to 40°K for Zr alloys containing 5 to 16 at.% Pu. Minima were observed in the region of 20°K for Pu concentrations up to 10 at.%, but for concentrations above 10 at.% Pu, the minimum disappeared. The results indicate that the 5f levels of Pu lie close to the Fermi level, thus behaving somewhat like the 4f electrons of Ce. Low-temperature resistivities were also measured for Sc–Pu, Y–Pu, Pd–Pu, Lu–Pu, and Th–Pu alloys; no minima were observed in these alloys, except for Sc alloys containing 15 and 25 at.% Pu, in which weak minima may have occurred at ~4°K. Possible explanations are given. (D.L.C.)

45359 LOW FIELD DC CONDUCTION IN YTTRIA-STABILIZED ZIRCONIA. Casselton, R. E. W. (International Research and Development Co., Ltd., Newcastle upon Tyne, Eng.). Phys. Status Solidi (a); 2: 571-85(16 Jul 1970).

Experimental measurements of the low-field dc conduction in both polycrystalline and single-crystal yttria-stabilized zirconia are presented. Comparison shows that conduction in the single-crystal material is little different from the polycrystalline counterpart. Results were obtained on a range of polycrystalline samples having yttria molar compositions between 5 and 20%, across the zirconia-rich cubic fluorite phase boundary, and the conductivity was shown to decrease with increasing penetration into the single-phase field. This behavior is discussed in terms of association of vacancies with cationic defects, and it is suggested that a concentration dependence on the activation energy for vacancy motion is not inconsistent with experimental observation. (auth)

45360 PARAMAGNETIC BEHAVIOR OF SOME INTERMETALLIC COMPOUNDS IN THE GADOLINIUM–COBALT SYSTEM. Burzo, E. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 689-94(1970).

The measurements carried out in the paramagnetic range in the intermetallic compounds Gd_2Co_7, $GdCo_3$, $GdCo_2$, and Gd_4Co_3 prove their ferrimagnetic character. A decrease of magnetic moment per cobalt atom with the increase of gadolinium content, similar with that characteristic in the order domain, was observed. Consequently, there exists a correspondence between values of the magnetic moments obtained from paramagnetic measurements and those determined by magnetic measurements at saturation. The results obtained are interpreted by a Friedel–Anderson model. (auth)

45361 MAGNETIC PROPERTIES OF THE INTERMETALLIC COMPOUNDS IN THE GADOLINIUM–COBALT SYSTEM. Burzo, E. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 573-85(1970).

The magnetic behavior of the intermetallic compounds is studied. Below Curie temperatures, except Gd_3Co, the gadolinium–cobalt compounds exhibit ferrimagnetic ordering. The forms of spontaneous magnetization–temperature curves, according to the Néel classification, are of P, M, N, and Q type, depending on the magnetic contribution of the two elements of the compound. In the paramagnetic region, in the case of $GdCo_3$ and Gd_2Co_7 compounds, the reciprocal molar magnetic susceptibility versus temperature follows a Néel type law, typical of ferrimagnetic behavior. The magnetic moment of cobalt atom decreases with gadolinium content by filling of the 3d band with conduction electrons contributed by gadolinium. (auth)

45362 ELECTRON DENSITY OF STATES IN Yb METAL AS OBSERVED BY X-RAY PHOTOEMISSION. Hagstroem, S. B. M. (Inst. of Tech., Linkoeping, Sweden); Heden, P. O.; Loefgren, H. Solid State Commun.; 8: 1245-8(1 Aug 1970).

X-ray photoemission measurements were made on in situ vacuum-evaporated films of ytterbium. The dominant features in the band structure part of the spectrum are the spin–orbit split 4f levels. These are located at 1.4 ± 0.4 eV and 2.7 ± 0.4 eV below the Fermi level. The large cross section for excitation of the 4f levels with x rays as compared to excitation with light is discussed. Measurements are also reported for the core levels $4d_{\frac{3}{2}}$ and $4d_{\frac{5}{2}}$. Their binding energies are determined to be 190.0 ± 0.8 eV and 181.2 ± 0.8 eV. (auth) (UK)

Moessbauer Effects and NMR

Refer also to abstracts 44299 and 44366.

45363 NMR RELAXATION IN HETEROGENEOUS SYSTEMS. Glasel, J. A. (Columbia Univ., New York). Nature (London); 227: 704-5(15 Aug 1970).

There has been recent discussion of difficulties in interpreting NMR line broadening in complex heterogeneous suspensions (Nature 225: 542,743 (1970). In the present communication, a study is described of relaxation in a well-defined physicochemical system, and the results for proton and deuteron relaxation are composed. The model system was constructed by packing optical crown glass spheres of known radius in an NMR sample tube with the excess volume filled with water; the spheres had a monomolecular surface coating of dimethylsilane. The results of proton T, (null point) and T_2 (Carr–Purcell–Meiboom–Gill) measurements as a function of radius for coated and uncoated spheres at 30 MHz and 26.5°C are shown. Similar results for T, (adiabatic fast passage) for D in ^2H_2O in analogously prepared samples are also shown. Two conclusions are reached: firstly, T_2 measurements carried out by the spin-echo Carr–Purcell method are not sufficient for determining rotational reorientation times for protons, since $T_2 \ll T_1$ in all systems; and secondly, proton measurements in such systems cannot be used to derive an intra-term, and therefore rotational reorientation times, since the change in proton T, as the surface-to-volume ratio increases is very much larger than that for deuteron T. The proton inter-term becomes very important, although it is negligible in D systems. Explanations are discussed. The findings apply to all experiments on heterogeneous and colloidal-biophysical systems. (UK)

45364 NATURAL LINEWIDTH OF THE MOESSBAUER LEVEL OF ^{119m}Sn. Lejeune, S.; Dehaes, J. C.; Drymael, H. (Univ. Libre, Brussels). Phys. Lett., 32A: 397-8(24 Aug 1970).

The natural linewidth of the 24-keV level of ^{119m}Sn was remeasured by Moessbauer spectroscopy and delayed coincidence giving a half life of 23 nsec, as compared with the standard value of 18.4 nsec. (auth)

45365 NUCLEAR MAGNETIC RESONANCE STUDIES OF ^{35}Cl, ^{37}Cl, ^{79}Br, AND ^{81}Br. Blaser, J.; Lutz, O.; Steinkilberg, W. (Univ., Tuebingen, Ger.). Phys. Lett., 32A: 403-4(24 Aug 1970).

The Larmor frequencies of ^{35}Cl, ^{37}Cl, ^{79}Br, and ^{81}Br were measured relative to the Larmor frequency of ^{2}H in aqueous solution, and nuclear magnetic moments were calculated for these nuclei. The solvent isotope effect on the chemical shift of the halide nuclei in aqueous solution was investigated. (auth)

45366 QUADRUPOLE INTERACTION OF ^{181}Ta IN HfO_2. Gardner, P. R.; Prestwich, W. V. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 1430-5(15 Jun 1970).

Studies are presented of the static quadrupole interaction of the 482-keV level of ^{181}Ta in a polycrystalline HfO_2 source, made using a differential perturbed angular correlation (PAC) method. The experimental procedure and method of analysis are described and the results obtained for the following interaction parameters are: the transition frequencies $\omega_0 = 819 \pm 10$, $\omega_1 = 1483 \pm 25$, $\omega_2 = 2350 \pm 50$ Mrad/s, the quadrupole interaction frequency $\omega_0 = 125.8 \pm 1.9$ Mrad/s, the asymmetry parameter $\eta = 0.283 \pm 0.027$, and the electric field gradient at active lattice sites $V_{zz} = 13.1 \pm 0.6 \times 10^{17}$ V/cm^2. These results are compared with those recently obtained by other workers in this field. (auth)

45367 DIRECT OBSERVATION OF ANOMALOUS TRANSMISSION OF RESONANT γ RAYS OF ^{57}Fe BY SINGLE-CRYSTAL Fe + 3% Si. Sklyarevskii, V. V.; Smirnov, G. V.; Artem'ev, A. N.; Mirzababaev, R. M.; Sestak, B.; Kadeckova, S. JETP Lett. (USSR) (Engl. Transl.); 11: 363-6(5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 531-4 (5 June 1970).

The angular dependence of the transmission was studied with a two-crystal Moessbauer diffractometer, using a source of ^{57}Co in stainless steel and good conditions of angular resolution (~7″). A $T_{res}\theta$ curve with a clearly pronounced peak of anomalous transmission in Bragg-angle region, $\theta = \theta_B$, was found. The $T_{res}\theta$ dependence showed a somewhat asymmetric dispersion form because of lack of thickness of the crystal. For the particular crystal investigated, the ratio of the amplitudes of scattering of the γ rays by nuclei and electrons $f_{nuc}/f_{el} \simeq 0.08$, showing the wave field in the crystal is formed mainly as a result of diffraction by electrons. (L.M.T.)

45368 MOESSBAUER MEASUREMENTS OF THE DEBYE-WALLER FACTOR OF GOLD IN PLATINUM AFTER LOW-TEMPERATURE NEUTRON IRRADIATION. Mansel, W. (Technische Hochschule, Munich); Vogl, G.; Vogl, W.; Wenzl, H.; Barb, D. Phys. Status Solidi; 40: 461-9(1 Aug 1970).

^{197}Pt, which decays with 20 hr half-life to ^{197}Au, is produced by irradiation of platinum samples with reactor neutrons at 4.6°K. At the same time, structural lattice defects are formed. Using the Moessbauer effect of ^{197}Au, the Debye–Waller factor of the gold atoms is measured. A reduction of up to approximately 10% in the Debye–Waller factor is found, which is attributed to radio-induced defects. This behavior is interpreted in terms of an interaction of defects formed by thermal and fast neutrons. A change of the coupling constant of the ^{197}Au atom to its neighbors is assumed to be responsible for the reduction of the Debye–Waller factor. (auth)

45369 MEASUREMENT OF THE TOTAL MAGNETIC SUSCEPTIBILITIES OF METALS BY NMR. Smithard, M. A.; Wynn, V. T. (Univ. of Exeter, Eng.). Phys. Status Solidi; 40: 531-6(1 Aug 1970).

The NMR technique for the measurement of magnetic susceptibilities is extended to include metals in polycrystalline and single-crystal forms. Measurements were made on cylindrical samples of copper, silver, gold, aluminum, magnesium, and beryllium. In particular, the variation in the magnetic susceptibility of a single crystal of beryllium is obtained as a function of its orientation in the magnetic field. The values for the two principal components of the susceptibility are shown to agree well with those obtained previously by a classical method. (auth)

45370 MOESSBAUER STUDY OF ^{161}Dy IN Gd_2O_3. Moerup, S.; Trumpy, G. (Technical Univ., Lyngby, Denmark). Phys. Status Solidi; 40: 759-61(1 Aug 1970).

Moessbauer studies were performed with a source consisting of ^{161}Tb in Gd_2O_3 and with ferromagnetic metallic dysprosium as an absorber. Hyperfine splitting of the ^{161}Dy, produced by the decay of ^{161}Tb in the source was obtained. The results are interpreted in terms of a pure quadrupole splitting of $e^2 q Q = 485$ MHz at room temperature. (auth)

45371 SUPPRESSION OF NUTATION ANGLE VARIATION IN PULSED NUCLEAR MAGNETIC RESONANCE. MacLaughlin, D. E. (Univ. of California, Riverside). Rev. Sci. Instrum.; 41: 1202-4(Aug 1970).

In pulsed nuclear magnetic resonance a random variation of the nutation angle is produced if the rf pulse initiation occurs at a random phase with respect to the rf carrier. The effect is most important at low resonance frequencies and large rf pulse amplitudes. An approximate calculation of the rms variation is presented, and a circuit is described which minimizes the variation by synchronizing the rf pulse with the rf phase. (auth)

45372 APPLICATION OF FREQUENCY LOCKING AND CONTROL TO AN AUTODYNE OSCILLATING NMR DETECTOR. Brandwein, Leonard; Lipsicas, Max (Yeshiva Univ., New York). Rev. Sci. Instrum.; 41: 1293-5(Sep 1970).

The use of an autodyne oscillating NMR detector is discussed with particular reference to experimental situations where signal averaging or magnet field locking are involved. A frequency locking scheme which has proved very useful in this connection is described. Some additional circuits used in this locking scheme are discussed as applied to a Robinson circuit. (auth)

45373 HIGH PRESSURE SAMPLE CELL FOR THE NMR RELAXATION TIME MEASUREMENTS IN LIQUIDS. Jonas, J.; Bull, T. E.; Ecker, C. A. (Univ. of Illinois, Urbana). Rev. Sci. Instrum.; 41: 1240-1(Aug 1970).

A simple high pressure rf sample cell which proved successful for the measurement of the NMR relaxation times in liquids at room temperature and at pressures up to 2 kilobars is described. (W.H.K.)

45374 ON THE MEASUREMENT OF SMALL OSCILLATIONS BY MEANS OF RESONANT γ-RAY ABSORPTION. Bonazola, G. C. (Univ., Turin); Chiavassa, E.; Maxia, V. Nucl. Instrum. Methods; 84: 257-60(1970).

The description of a method for measuring the velocity amplitude of small oscillations by means of Moessbauer effect is given. Theoretical equations are deduced which enable conditions for the best sensitivity to be determined. Some clarifying experimental results are reported. (auth)

45375 KNIGHT SHIFT AND ZERO-FIELD SPLITTING IN RHENIUM DETERMINED BY NUCLEAR ACOUSTIC RESONANCE. Buttet, J. (California Inst. of Tech., Pasadena); Baily, Philip K. Phys. Rev. Lett.; 24: 1220-3(1 Jun 1970).

Nuclear acoustic resonance signals have been observed in a single crystal of rhenium metal. From measurements of the resonance fields at different frequencies, values for the Knight shift and zero-field splitting at 4.2°K are obtained. The Knight shift, referred to aqueous $NaReO_4$, is found to be $(1.02 \pm 0.06)\%$. The zero-field splitting, $3e^2qQ/20h$, is found to be 40.6 ± 0.35 MHz for ^{185}Re and 38.35 ± 0.2 MHz for ^{187}Re. (auth)

45376 NUCLEAR MAGNETIC RESONANCE IN DILUTE INDIUM–CADMIUM, INDIUM–MERCURY, AND INDIUM–THALLIUM ALLOYS. Thatcher, Frederick Clarence. Riverside, Calif.; Univ. of California (1969). 124p. University Microfilms Order No. 70-6372.

Thesis.

Nuclear magnetic resonance was observed in the indium-rich alloys In–Cd, In–Hg, and In–Tl at 4.2°K. Measurements have been made of the isotropic Knight shift, anisotropic Knight shift, quadrupole coupling frequency, and line widths of the ^{115}In nuclear resonance as a function of solute concentration to 4.7 at. % Cd, 4.3 at. % Hg, and 7.9 at. % Tl. A theory is developed for line widths and line shapes in dilute indium alloys. The quadrupole coupling is found to depend strongly on the c/a ratio, and weakly on the atomic volume and impurity scattering. The enhancement factor of Kohn and Vosko is determined to be 85 ± 15. The isotropic Knight shift exhibits a dip similar to that previously observed in In–Sn and In–Pb. It is proposed that the isotropic Knight shift behavior in the dilute region is due to averaging of anisotropic electron–electron interactions as a result of impurity scattering. (Diss. Abstr. Int., B)

45377 LEVEL CROSSING IN HYPERFINE INTERACTIONS STUDIED BY PERTURBED γ–γ ANGULAR CORRELATIONS. Lieder, R. M.; Buttler, N.; Killig, K.; Beck, K. (Univ., Bonn). Z. Phys.; 237: 137-54(1970).

The technique of differential γ–γ angular correlation measurements has been applied to an investigation of the hyperfine interactions in the 482-keV level of ^{181}Ta. The activity was embedded in the lattice of a hafnium single crystal. The investigation of the quadrupole interaction gave for the electric interaction frequency $\omega_0 = (313 \pm 4)$ MHz. The electric field gradient was found to be axially symmetric, the asymmetry parameter being $\eta < 0.1$. Furthermore the combined collinear magnetic dipole and electric quadrupole interaction was studied. The angular correlation was investigated as a function of the strength of the external magnetic field by integral as well as time differential measurements. The integral anisotropy as function of the magnetic field has the shape

of a resonance curve. The maximum was observed at a magnetic field of $B_{res} = (24.2 \pm 0.5)$ kG. (auth)

Theory

45378 MEAN FREE PATH OF RELATIVISTIC ELECTRONS FOR PLASMON EXCITATION. Ashley, J. C.; Ritchie, R. H. (Oak Ridge National Lab., Tenn.). Phys. Status Solidi; 40: 623-30(1 Aug 1970).

The interaction of a relativistic electron with a system of plasmons is considered. First-order perturbation theory is used to calculate the rate of excitation of plasmons by the incident electron; the excitation rate leads to a mean free path. It is shown that relativistic corrections to the mean free path are generally quite negligible and thus the mean free path calculated using a nonrelativistic incident electron, when expressed in the "proper fashion," is also correct relativistically. (auth)

Theoretical Physics

45379 ELECTRON SPIN AND RADIATIVE REACTION. Browne, P. F. (Univ. of Manchester, Eng.). Ann. Phys. (N. Y.); 59: 254-8(Jul 1970).

Spin effects are extracted from the Lorentz–Dirac equations of motion of a point charge without the introduction of additional empirical parameters. The effective motion of the particle is distinguished from the motion of the point electron which performs a classical Zitterbewegung. Introducing parameters to describe the effective motion, radiative reaction disappears and spin angular momentum appears. A new condition for the rate of radiation emerges. (auth)

45380 STATISTICAL BASIS FOR QUANTUM THEORY: THE EMBEDDING FORMALISM. Collins, R. E. (Univ. of Houston, Tex.). Phys. Rev., D; 2: 666-73(15 Aug 1970).

The formulation of quantum theory on the basis of the statistical definition of a duplicated experiment, as initiated in a recent paper, is used to reexamine the embedding formalism introduced in earlier papers. It is shown that the familiar relations between momentum and coordinate representations are given a statistical basis by the embedding theory. It is also shown that a complete quantum theory includes three fundamental sets of operators and that one of these seems to represent an operator formalism for thermodynamics. (auth)

45381 SET OF GENERALIZED UNCERTAINTY RELATIONS AND THE NATURE OF THE UNCERTAINTY PRINCIPLE. Silvert, William (Univ. of Kansas, Lawrence). Phys. Rev., D; 2: 633-4(15 Aug 1970).

A set of generalized uncertainty relations is derived for periodic systems. In the appropriate limits, they reduce to results previously obtained. The uncertainty principle is seen to express a relationship between the Fourier components of the wave function, ψ, and those of the probability density, $|\psi|^2$. (auth)

45382 EXPANSION IN EIGENFUNCTIONS OF A NON-SELF-ADJOINT SCHROEDINGER'S OPERATOR. Ramm, A. G. (Leningrad Inst. of Fine Mechanics and Optics). Dokl. Akad. Nauk SSSR; 191: 50-3(1 Mar 1970). (In Russian).

A simple proof is presented on the theorem of expansion of a non-self-adjoint Schroedinger's operator; the proof is of special interest for nuclear physics. Integration of the twice-differentiated finite function was carried out in all three dimensions. This approach has been considered earlier by A. Ya. Povzner. The method described may be used to prove the expansion in eigenfunctions of a Schroedinger operator of the Dirichlet boundary problem at the external portion of a boundary region possessing a sufficiently smooth stellar boundary and lying within the angular region. (TTT)

45383 WHAT IS "QUANTUM-LOGIC"? Jauch, J. M.; Piron, C. (Univ. of Miami, Fla. Univ., Geneva). pp 166-81 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

A short introduction and survey of the calculus often called "quantum logic," is presented, and the difficulties which prevent this calculus to be considered as a logic are pointed out. It is furthermore shown that the probability calculus for a quantal system is a generalization of the classical probability calculus, which gives a more general meaning to the notion of random variable. (auth)

45384 POTENTIAL PROBLEMS INVOLVING THE SPACE OUTSIDE A CIRCULAR DISK. Laporte, Otto; Ford, George W. (Univ. of Michigan, Ann Arbor). pp 357-66 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

A method is explained by which it is possible to construct a Laplace-equation Green's function for an infinite space external to a circular disk on which either the function or its normal derivative should vanish. The process can be modified to apply to a space exclusive of an infinite plane screen with a circular aperture in it. A variety of problems can be attacked with this technique, e.g., diffraction around disks and through apertures at long wave lengths and in inviscid hydrodynamics currently being used in superfluid helium studies. It is intended to apply this method to the discussion of vortex rings. (L.M.T.)

45385 POLARIZATION IN INVERSE COMPTON EFFECT. Bonometto, S. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Cazzola, P.; Saggion, A. Astron. Astrophys.; 7: 292-304(Aug 1970).

A general analysis of polarization in inverse compton scattering for arbitrary distributions of photons and electrons is carried out. Simple formulae for the Stokes parameters of the scattered radiation are obtained when the Thomson approximation holds in the center of mass system. The case of a monochromatic photon beam is studied in detail since it provides a basis for a study of the more general case. (auth)

45386 HYDRODYNAMIC ANALOGIES TO QUANTUM MECHANICS. Wallner, L. G. (Univ. of Libya, Tripoli). pp 479-80 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

In Schroedinger's wave mechanics, this article starts with the function of action W taken as a flow of a fluid mass continuum moving with the particles as in hydrodynamics rather than in a point-mechanical sense. The flow of N wave cycles connected with the moving particle is given by $W = \int mv\, dr = hN$, and the quantum of action is considered as the flow of one translational wave cycle. The wave equation developed is considered in analogy with the Hamilton–Jacobi equation and the equation for stationary vortices developed by Gromeki, Beltrami, and Trkal. (L.M.T.)

45387 ANALYTICAL INTEGRATION OF THE MOLIERE'S DISTRIBUTION FUNCTION FOR THE MULTIPLE SCATTERING OF CHARGED PARTICLES. Ito, Rinsuke. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 42-4(1969).

An analytical expression is given of the integral angular distribution function for the multiple scattering of charged particles in the theory developed by Molière. Values of the integral partial function $\int_0^\vartheta f^{(n)}(\vartheta)\vartheta d\vartheta$ (n = 0, 1, 2) are tabulated for ϑ up to 10. (auth)

45388 UPPER BOUNDS TO THE OVERLAP BETWEEN APPROXIMATE AND EXACT WAVE FUNCTIONS. Cohen, Maurice (York Univ., Toronto. Hebrew Univ., Jerusalem); Feldmann, Tova. Can. J. Phys.; 48: 1681-6(15 Jul 1970).

Rigorous lower and upper bounds to the eigenvalues E of a quantum-mechanical system with Hamiltonian operator H are derived from the Gramian determinant of a set of suitably chosen functions. This procedure, which also yields a rigorous upper bound to the overlap between a given trial function and the corresponding (unknown) exact eigenfunction, is shown to be equivalent to a generalization of the classical procedure of Weinstein. In the absence of a rigorous lower bound to the overlap, the present procedure provides a practical method of assessing the influence of the ground state on a given trial function for an excited state. (auth)

45389 NEW TYPE OF QUANTUM ELECTROMAGNETIC WAVES IN A STRONG MAGNETIC FIELD. Demikhovskii, V. Ya.; Protogenov, A. P. (Gorky State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 11: 409-11(20 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 591-4 (20 Jun 1970).

Dispersion relations were obtained for low-frequency right-polarized electromagnetic waves propagating along a magnetic field in an electron gas. Landau damping regions are considered. (M.O.W.)

45390 SCHROEDINGER EQUATIONS ACCOUNTING FOR SIZE EFFECTS IN SIMPLEST SAMPLES. Garczynski, W. (Univ. of Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 18: 161-3(1970).

The equations for particles in spherical, cylindrical, and two other geometries are described. (M.O.W.)

45391 SOLUTION OF THE DIRAC EQUATION FOR OBLIQUE ELECTRIC AND MAGNETIC FIELDS. Holz, A. (Lehigh Univ., Bethlehem, Pa.). Lett. Nuovo Cim.; 4: 26-30(4 Jul 1970).

The above solution is considered for the first time because of the importance of the configuration in plasma and astrophysical problems. It is pointed out that the solution could have been obtained as well by solving the case of parallel electric and magnetic fields and transforming it by means of Lorentz transformation into the oblique case. (L.M.T.)

45392 SIMPLE ALTERNATIVE TO DOUBLE GROUPS. Brown, E. (State Univ. of New York, Albany. Rensselaer Polytechnic Inst., Troy, N. Y.). Amer. J. Phys.; 38: 704-15 (Jun 1970).

The representations of point groups appropriate to spin-½ particles is usually determined by consideration of a group of double the order of the point group under consideration, known as the double group. An alternative approach is described which makes use of ray representations. The character tables for the 32 crystallographic point groups are derived simply by means of this approach. (auth)

45393 HAMILTONIANS AND WAVE EQUATIONS FOR PARTICLES OF SPIN 0 AND SPIN ½ WITH NONZERO MASS. Arunasalam, V. (Princeton Univ., N. J.). Amer. J. Phys.; 38: 1010-22(Aug 1970).

The formal mathematical structure of the truly Hamiltonian formulations of nonrelativistic and relativistic quantum mechanics is critically examined for both spin-0 and spin-½ particles with nonzero mass. It is shown that the relativistic quantum mechanics can, in principle, at least be fitted into a truly covariant Hamiltonian procedure where the Hamiltonian is a Lorentz-invariant world scalar (and is the negative of ½ the rest energy of the particle, regardless of its spin). In particular, a truly covariant Hamiltonian theory of the electron is presented. It will be seen that the Lorentz-invariant Dirac theory of the electron does not fall within the framework of a truly covariant Hamiltonian procedure. Further, the dynamical variables associated with the translational degree of freedom of the particle (such as the position, the canonical momentum, and the velocity four-vectors of the relativistic quantum mechanics) correspond precisely to the same variables of the truly covariant formulation of relativistic classical mechanics. The mathematical structure of relativistic quantum mechanics is seen to be rather similar to that of nonrelativistic quantum mechanics for both spin-0 and spin-½ particles with nonzero mass. (auth)

45394 EIGENVALUES OF TWO- AND THREE-DIMENSIONAL SYSTEMS BY MATRIX METHODS. Nicola, Michel (Shimer Coll., Mount Carroll, Ill.). Amer. J. Phys.; 38: 1225-9(Oct 1970).

A new method for finding the eigenvalues of two- and three-dimensional systems using matrices is given. The method is based on the principle that a physical variable takes on all the classically permissible values except those ruled out by the uncertainty principle and by the noncommutativity of some of the dynamical variables composing the system. Thus, the uncertainty principle is shown to yield positive results in spite of its negative character. (auth)

45395 REFLECTIONS ON A WAVE-PACKET APPROACH TO QUANTUM-MECHANICAL BARRIER PENETRATION. Bramhall, Mark H.; Casper, Barry M. (Carleton Coll., Northfield, Minn.). Amer. J. Phys.; 38: 1136-45(Sep 1970).

The time development of a one-dimensional Gaussian wave packet is considered. Noting that the quantum-mechanical predictions concerning position and momentum measurements of a free particle described by a Gaussian packet are consistent with the predictions one would make on the basis of a classical "Naive Model," one investigates whether this model can account for the scattering of a particle by a rectangular barrier. Obtaining numerical solutions of the time-dependent Schroedinger equation for a series of packets with varying incident momenta, one finds that the Naive Model is inadequate to explain the quantum-mechanical transmission. The relative speeds of the transmitted and reflected packets are studied, discussing a number of possible interpretations and indicating the quantum-mechanical result. Finally, it is noted that for certain choices of the parameters describing the packet and the barrier, the reflected packet is composed of two distinct humps. (auth)

45396 HIDDEN VARIABLES AND QUANTUM MECHANICAL PROBABILITIES. Wigner, Eugene P. (Princeton Univ., N. J.). Amer. J. Phys.; 38: 1005-9(Aug 1970).

An argument, due originally to J. S. Bell, is somewhat simplified and made more specific. It deals primarily with a quantum mechanical system consisting of the spins of two spin-½ particles. It shows that a description of the quantum-mechanical measurement of the spin components of these two particles by means of hidden parameters is impossible if we assume that the parameters determining the outcome of the measurement of the spin of each particle are independent of the direction in which we decide to measure the spin of the other particle. The mathematical reason for the impossibility is analyzed. (auth)

45397 MECHANICAL ANALOGS TO THE SOLUTION OF THE TIME-INDEPENDENT SCHROEDINGER WAVE EQUATION. Smith, J. Lynn (Physical Sciences Lab., Redstone Arsenal, Ala.). Amer. J. Phys.; 38: 731-5(Jun 1970).

Mechanical systems are described that serve as analogs to phenomena associated with the time-independent Schroedinger wave equation. The constraints necessary to effect a correspondence between the solutions of the time-independent analog wave equation and those in the Schroedinger case are pointed out. The parameters in the mechanical systems that correspond to energy, mass, etc., in the Schroedinger case are arrived at, and the quantitative limits of these parameters for physical meaningfulness are discussed. The feasibility of selecting real materials for the construction of the analogs is established. (auth)

45398 GAUGE INVARIANCE AND THE HAMILTON–JACOBI EQUATION. Motz, L. (Columbia Univ., New York). Nuovo Cim.; 69B: 95-104(11 Sep 1970).

It is shown that the Weyl gauge-invariance theory generates a class of scalar functions S that can be identified with the Hamiltonian action if certain restrictions are imposed upon the path along which a classical particle is allowed to move. By restricting the path in such a way that no change occurs in the dimensions of the particle, one finds that S satisfies the relativistic Hamilton–Jacobi equation. If one relaxes this restriction and assigns to the particle a bundle of classical paths with a cross-sectional diameter equal to the de Broglie wavelength, one obtains the Klein–Gordon wave equation and the Feynman sum-of-paths integral. (auth)

45399 SYMMETRY NUMBER IN CLASSICAL STATISTICAL MECHANICS. Nishioka, Kazumi; Pound, G. M. (Stanford Univ., Calif.). Amer. J. Phys.; 38: 1211-20(Oct 1970).

The quantum statistical treatment of the symmetry number is briefly reviewed for comparison with the classical statistical treatment. The concept of a localized system is discussed as a convenient method to calculate the classical partition function. The symmetry number in classical statistical mechanics is then defined, and it is applied to some examples. The classical phase integral is discussed as a limiting case of the canonical partition function in quantum statistical mechanics in the Appendix in order to make the meaning of the classical phase integral clear with respect to identity of particles, which is needed for the present purpose. (auth)

45400 DERIVATION OF THE MACROSCOPIC MAXWELL EQUATIONS. Russakoff, G. (Cornell Univ., Ithaca, N. Y.). Amer. J. Phys.; 38: 1188-95(Oct 1970).

Macroscopic Maxwell equations are derived from the microscopic equations of electrodynamics. The method is based on a modified version of spatial averaging and unifies several past approaches. For simplicity, the derivation presented here is restricted to classical systems, although it may easily be extended to incorporate quantum mechanical systems. (auth)

45401 SEPARATION OF TWO-PARTICLE COULOMB'S SINGULARITIES IN THE SYSTEM OF THREE CHARGED PARTICLES. Veselova, A. M. (Leningrad State Univ.). Teor. Mat. Fiz.; 3: 326-31(Jun 1970). (In Russian).

The system consisting of three charged particles is considered. The regular system of integral equations for the bound-state scattering problem below the ionization threshold is obtained. The kernels of these integral equations are expressed in terms of the solutions of the corresponding two-body problems only. (auth)

45402 LORENTZ TRANSFORMATIONS NOT ALTERING THE VALUE OF ELECTRIC INTENSITY VECTOR AND MOTION OF ELECTRIC CHARGES IN STATIONARY UNIFORM ELECTROMAGNETIC FIELDS. Tarnovskii, A. S. Izv. Vysah. Ucheb. Zaved., Aviats. Tekh.; No. 5, 109-10(1970). (In Russian).

It was resolved that in the system of measurements closely related to the charge moving in a constant and homogeneous electromagnetic field the electric vectors of magnetic induction and gravitational field intensity do not change their magnitudes with time, but rotate as a unified system with a certain constant angular velocity. (R.V.J.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

45403 REVIEW OF PARTICLE PROPERTIES. Roos, Matts (CERN, Geneva); Bricman, Claude; Barbaro-Galtieri, Angela; (and others). Phys. Lett.; 33B: 1-127(Aug 1970).

This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group [Rev. Mod. Phys. 42 (1970) 87]. Data are evaluated, listed, averaged, and summarized in tables. A data booklet is also available. (auth)

Electromagnetic

45404 (PURC-4159-3) NEUTRAL BRANCHING RATIOS OF THE ETA MESON. Buttram, Malcolm T.; Kreisler, Michael N.; Mischke, Richard E. (Princeton Univ., N. J. Joseph Henry Labs.). Jul 1970. Contract AT(30-1)-4159. 12p. (CONF-700806-28). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

The neutral branching ratios of the eta meson were determined from the energy spectrum of single gamma rays in the eta center-of-mass. The sample of 7200 events after background subtraction yields $(\eta \to 3\pi^0)/(\eta \to \gamma\gamma) = 0.82 \pm 0.05$ and $(\eta \to \pi^0\gamma\gamma)/(\eta \to \gamma\gamma) = 0.05 \pm 0.04$ under the assumption that no other neutral decay modes contribute. The quoted errors include an estimate of possible systematic effects. (auth)

45405 MEASUREMENTS OF THE POLARISATION OF THE RECOIL PROTON IN ELASTIC ELECTRON PROTON SCATTERING AT $q^2 = 1.3$, 1.5, AND 1.9 $(GeV/c)^2$. Kirkman, H. C. (Univ. of Glasgow); Railton, R.; Rutherglen, J. G.; (and others). Phys. Lett.; 32B: 519-22(17 Aug 1970).

An experiment was carried out to determine the imaginary part of the two-photon exchange amplitude by measuring the polarization of the recoil proton in elastic electron-proton scattering. The polarization was found to be -0.006 ± 0.030 at $q^2 = 1.3$ $(GeV/c)^2$, $+0.052 \pm 0.055$ at 1.5 $(GeV/c)^2$ and $+0.065 \pm 0.087$ at 1.9 $(GeV/c)^2$. (auth)

45406 PHOTOPRODUCTION OF K^+ MESONS AND POLARIZATION OF Λ^0 HYPERONS IN THE 1-GeV RANGE. Fujii, T. (Tokyo Univ.); Imanishi, A.; Iwata, S.; (and others). Phys. Rev., D; 2: 439-48(1 Aug 1970).

Polarization of Λ hyperons and differential cross sections for the reaction $\gamma + p \to K^+ + \Lambda$ were measured at the K^+-meson center-of-mass angles around 45°, 70°, and 90° for the incident photon energies of 1054, 1100, and 1160 MeV. The K^+ mesons were detected with a magnetic spectrometer and a velocity-selection system based on the energy loss and the time of flight. The polarization of Λ was determined by measuring the up-down asymmetry of protons in the decay $\Lambda \to p\pi^-$ with respect to the production plane. The results show a dominant $\sin\theta_K^*$ dependence of the polarization at the region of the third resonance and are consistent with a contribution of the P_{11} resonance with a mass of about 1700 MeV. (auth)

45407 ASYMMETRIC ELECTRON PAIR PRODUCTION OF CARBON. Simonds, R. M. (Stanford Univ., Calif.); Richter, B. Contract Nonr 225(67). Phys. Rev., D; 2: 417-29(1 Aug 1970).

The cross section for the reaction $\gamma + C \to e^+ + e^- + C$ was measured for a series of kinematic points giving nuclear momentum transfers in the region $0.2 - 0.7$ F^{-2}, with incident photon energies in the region for photoproduction of the first pion-nucleon resonances. Measurements were made, using asymmetric detection geometry, of electron and positron cross sections for each point. The charge-independent yields are shown to be in agreement with predictions of quantum electrodynamics for coherent and quasi-elastic production on carbon. The charge-asymmetric results are shown to be consistent with recent estimates of the interference between Bethe-Heitler and Compton pair production amplitudes with excitation of an intermediate π-N state in the Compton diagram. (auth)

45408 EXPERIMENTAL DETERMINATION OF THE DALITZ-PLOT DISTRIBUTION OF THE DECAYS $\epsilon \to \pi^+\pi^-\pi^0$ AND $\epsilon \to \pi^+\pi^-\gamma$, AND THE BRANCHING RATIO $\epsilon \to \pi^+\pi^-\gamma/\epsilon \to \pi^+\pi^-\pi^0$. Gormley, M.; Hyman, E.; Lee, W.; Nash, T.; Peoples, J.; Schultz, C.; Stein, S. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 2: 501-5(1 Aug 1970).

The Dalitz-plot distribution of the two dominant charged decays of the η meson was analyzed. From 7250 examples of $\eta \to \pi^+\pi^-\gamma$, it is found that the γ-ray energy spectrum disagrees with the simplest gauge-invariant matrix element corresponding to the dipion in the J = 1 state. However, it agrees well with a simple ρ-dominant model. The π^0 energy spectrum of 30,000 examples of $\eta \to \pi^+\pi^-\pi^0$ was fitted to a power-series expansion of the matrix element in the usual Dalitz coordinates. It is found that a matrix element linear in the π^0 kinetic energy does not fit the data. The branching ratio $\eta \to \pi^+\pi^-\gamma/\eta \to \pi^+\pi^-\pi^0$ was measured to be 0.201 ± 0.006. (auth)

45409 TOTAL HADRONIC (γ,p) AND (γ,d) CROSS SECTIONS FROM 4 TO 18 GeV. Caldwell, D. O. (Univ. of California, Santa Barbara); Elings, V. B.; Hesse, W. P.; Morrison, R. J.; Murphy, F. V.; Worster, B. W.; Yount, D. E. Phys. Rev. Lett.; 25: 609-12(31 Aug 1970).

Photoabsorption cross sections in hydrogen and deuterium were measured from 3.7 to 17.9 GeV. The energy dependences are similar to those of strong-interaction total cross sections, as expected from the vector-meson-dominance model. The magnitude of $\sigma_T(\gamma p)$ can be compared with data from $\gamma p \to \rho^0 p$ to determine a γ-p coupling constant, $\gamma\rho^2/4\pi = 0.37 \pm 0.03$. This value disagrees with that obtained on the ρ mass shell, and hence there is only qualitative agreement with the vector-meson-dominance model. (auth)

45410 PHOTONUCLEON TOTAL CROSS SECTIONS AT VERY HIGH ENERGY. Hesse, W. P. (Univ. of California, Santa Barbara); Caldwell, D. O.; Elings, V. B.; Morrison, R. J.; Murphy, F. V.; Worster, B. W.; Yount, D. E. Phys. Rev. Lett.; 25: 613-16(31 Aug 1970).

Photon-neutron total cross sections were evaluated from the data for the proton and deuteron presented previously. Simple Regge-pole fits were made to $\sigma_T(\gamma p)$ and $\sigma_T(\gamma n)$, both of which extrapolate to 94 ± 4 μb at infinite energy. Over the range of data, 3.7 to 17.9 GeV, $\sigma_T(\gamma n) < \sigma_T(\gamma p)$, which can be interpreted to give a ratio of exchange contributions, $A_2/P' = 0.19 \pm 0.04$. A fit to $\sigma_T(\gamma p)$ is also important for predictions of the proton cosmic-ray spectrum. (auth)

45411 PRECISION MEASUREMENT OF THE MAGNETIC MOMENT OF THE MUON. Hague, J. F. (Univ. of Washington, Seattle); Rothberg, J. E.; Schenck, A.; Williams, D. L.; Williams, R. W.; Young, K. K.; Crowe, K. M. Phys. Rev. Lett.; 25: 628-31(31 Aug 1970).

The ratio of muon to proton magnetic moment, μ_μ/μ_p was measured to high precision in three chemical environments. The agreement shows that the "Ruderman correction" is not applicable. The result is $\mu_\mu/\mu_p = 3.183\ 347(9)$ (2.8 ppm); in terms of the muon mass, this implies $m_\mu/m_e = 206.7683(6)$. (auth)

45412 PRECISION DETERMINATION OF THE MAGNETIC MOMENT OF THE PROTON IN NUCLEAR MAGNETONS. Fystrom, Dell Orren. Boulder, Colo.; Univ. of Colorado (1969). 108p. University Microfilms Order No. 70-5846.

Thesis.

A rectangular charge collecting omegatron with a uniform radio frequency electric field was used to measure the cyclotron resonance frequency of several different ions. Extrapolation to zero mass was used to correct for space charge shifts, with care being taken to see that the space charge was not substantially changed when different ion resonances were being observed. A magnetic field of 16 kilogauss was used, and the homogeneity was 12 parts in 10^6 over the region of ion cycling. Cyclotron resonance line widths of less than one part in 50,000 were observed for small radio frequency electric field amplitudes. However, for large amplitude radio electric fields trapezoidal line shapes which closely approximate square shape were found. With this large radio frequency field amplitude proton line shapes with asymmetries of approximately 3 parts in 10^7 were observed for the best operating conditions. The asymmetries were larger for higher mass ions, but still relatively small. Measurements of the cyclotron resonance frequency of H^+ and D^+ were used with values of the field measurement to obtain the value of the magnetic moment of the proton in units of the nuclear magneton. The value obtained, uncorrected for diamagnetism, was 2.792780. The 70 per cent confidence estimate including both random and systematic errors, is estimated to be 11 parts in 10^6. (TSS) (Diss. Abstr. Int., B)

45413 PHOTOPRODUCTION OF $\pi^+\Delta(1236)$ FROM HYDROGEN AND DEUTERIUM AT 16 GeV. Boyarski, A. M.; Diebold, R.;

Ecklund, S. D.; Fischer, G. E.; Murata, Y.; Richter, B.; Sands, M. (Stanford Univ., Calif.). Phys. Rev. Lett.; 25: 695-9(7 Sep 1970).

Cross sections for $\gamma p \to \pi^- \Delta^{++}$, $\gamma n \to \pi^- \Delta^+$, $\gamma p \to \pi^+ \Delta^0$, and $\gamma n \to \pi^+ \Delta^-$ were measured at 16 GeV for momentum transfers $-t \leq 2$ GeV^2. The charge-symmetric cross sections differ by typically a factor of 2, indicating interference between isoscalar and isovector photon amplitudes. The ratio of $\pi^+\Delta^0$ and $\pi^+\Delta^-$ cross sections is not consistent with pure isospin I = 1 exchange in the t channel, appreciable I = 2 exchange being required. A factor-of-5 discrepancy is found for a vector-dominance plus line-reversal prediction. (auth)

45414 UPPER LIMIT OF THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Apostolescu, S.; Ionescu, D. R.; Ionescu-Bujor, M.; Meitert, S.; Petrascu, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 343-53(1970).

The neutron magnetic resonance was used in the determination of the electric dipole moment of the neutron. An improved spectrometer was used having 1.8 m distance between the rf coils and an elaborate magnetic shielding consisting of eight strata of ARMCO iron. The electric field was 95 kV/cm. No value of the electric dipole moment could be put into evidence in the limits of the errors, so a value of $(-0.2 \pm 3.9) \times 10^{-22}$ cm for (μ_e/e) was established, in good agreement with previous results. (auth)

Weak

45415 PRECISION DETERMINATION OF THE $K_L - K_S$ MASS DIFFERENCE. Cullen, M.; Darriulat, P.; Deutsch, J.; (and others). Phys. Lett.; 32B: 523-7(17 Aug 1970).

The $K_L - K_S$ mass difference was measured to be $\delta m = (0.542 \pm 0.006) \times 10^{10}$ sec^{-1}. Combined with $K_L - K_S$ interference experiments in the $\pi^+\pi^-$ decay channel, the experiment gives an improved value for arg $(K_L \to \pi^+\pi^-/K_S \to \pi^+\pi^-)$. (auth)

45416 MEASUREMENT OF THE BRANCHING RATIO OF THE CP-VIOLATING DECAY MODE $K_L^0 \to 2\pi^0$. Budagov, I. A. (CERN, Geneva); Cundy, D. C.; Myatt, G.; (and others). Phys. Rev., D; 2: 815-27(1 Sep 1970).

The branching ratio $\Gamma(K_L^0 \to 2\pi^0)/\Gamma(K_L^0 \to 3\pi^0)$ was measured directly, using a heavy-liquid bubble chamber, and was found to be $(3.2 \pm 1.5) \times 10^{-3}$, from which $|\eta_{00}| = (1.9 \pm 0.5) \times 10^{-3}$. (auth)

Strong (Baryon-Induced)

45417 DOUBLE PION PRODUCTION IN ANTIPROTON–DEUTERON AND PROTON–PROTON COLLISIONS AT 2.8 GeV/c. Borak, Thomas Benjamin. Nashville; Vanderbilt Univ. (1969). 201p.

Thesis.

An analysis was performed on three- and four-pronged events observed in the BNL 20-in. deuterium-filled bubble chamber exposed to 2.8-GeV/c antiprotons. The reactions of interest are those where two pions are produced in the final state without annihilation. A similar double pion final state produced in proton-proton collisions at the same energy is also studied. An attempt was made to explain the data with an absorptive one-pion-exchange model for the quasi-two-body final state $\bar{N}N \to \bar{N}^* N^*$ and $NN \to N^* N^*$. Here N^* represents the P_{33} nucleon resonance at 1238 MeV. This procedure proved unsatisfactory due to the asymmetry in the isobar decay distributions and extreme peripherality of the pp reaction. A new model was then constructed which consisted of the amplitude corresponding to a one-pion-exchange diagram. The two body mass and scattering angular distributions were in good agreement with this model. However there existed a large excess of events in the region near threshold of the $N\pi\pi$ and $\bar{N}\pi\pi$ effective mass distribution in the $\bar{N}N$ reactions. In order to account for this structure a resonant amplitude with a $N^*(1238)\pi$ decay mode was incoherently added to the one-pion-exchange amplitude. This model (without a phase space contribution) produced considerably better fits to the three body mass spectrum without affecting the two body mass and angular distributions. Therefore the data appear to be consistent with the production of a resonance of mass 1400 MeV and width 80 MeV which decays isotropically into $N^*(1238)\pi$. (TSS) (Diss. Abstr. Int. B)

45418 HIGH-PRECISION MEASUREMENT OF THE ANISOTROPY OF THE n–p DIFFERENTIAL CROSS SECTION AT 14 MeV. Arvieux, J.; Pouxe, J. (Institut des Sciences Nucleaires, Grenoble, France). Phys. Lett.; 32B: 468-70 (17 Aug 1970).

The anisotropy $R = \sigma(180°)/\sigma(\theta)$ of the n-p scattering cross section was measured for three different c.m. angles θ. The results are $R = 1.036 \pm 0.013$ for $\theta = 100°$, $R = 1.021 \pm 0.018$ for $\theta = 90°$ and $R = 1.034 \pm 0.018$ for $\theta = 80°$. They are in better agreement with the "ϵ_1 constrained" phase shift analysis from Livermore and the Yale YIV solution, than with the "ϵ_1 free" solution. (auth)

45419 STUDY OF THE $\bar{p}d \to p_s \bar{p}p\pi^-$ REACTION AT 5.5 GeV/c. Braun, H.; Evrard, D.; Fridman, A.; Gerber, J.-P.; Maurer, G.; Michalon, A.; Schiby, B.; Strub, R.; Voltolini, C.; Cueer, P. (Centre de Recherches Nucleaires, Strasbourg). Phys. Rev., D; 2: 488-500(1 Aug 1970).

Based on 150,000 photographs taken with the 30-in. bubble chamber at the ZGS, a study of the $\bar{p}d \to p_s \bar{p}p\pi^-$ reaction is presented. Important production of $\bar{\Delta}^{--}(1236)$ is observed. The distribution of the momentum transfer between the incident $\bar{p}$ and the final $\bar{\Delta}^{--}(1236)$ is compared with data at other energies and also with the crossed $pp \to \Delta^{++}n$ reaction. That the peaking of the momentum transfer tends to be greater for the $pp \to \Delta^{++}n$ than the $\bar{p}n \to \bar{\Delta}^{--}p$ reaction at 5.5 GeV/c can be explained by using a simple Regge-pole model. For events produced without resonance in the final state, the longitudinal phase-space analysis is applied to the data. For these events, an attempt was also made to use a double Regge-pole model to describe the production. The present version of this model reproduces the experimental data fairly well. Using the Fermi motion of the neutron target, an attempt is made to extract information about the variation of the $\bar{p}n \to \bar{p}p\pi^-$ cross section with c.m. energy. In connection with this problem, a discussion on the validity domain of the impulse approximation is given. (auth)

45420 DOUBLE-PION PRODUCTION REACTIONS IN $\bar{p}n$ COLLISIONS AT 2.8 GeV/c. Bacon, T. C.; Bomse, F.; Borak, T. B.; Fickinger, W. J.; Goza, E. R.; Moses, E. J.; Salant, E. O. (Vanderbilt Univ., Nashville). Phys. Rev., D; 2: 463-82(1 Aug 1970).

The reactions $\bar{p}n \to \bar{p}n\pi^+\pi^-$, $\bar{p}n \to \bar{p}p\pi^-\pi^0$, and $\bar{p}n \to \bar{n}p\pi^-\pi^-$ at 2.8-GeV/c incident $\bar{p}$ laboratory momentum are analyzed with data from the Brookhaven National Laboratory 20-in. bubble chamber. $N^*(1238)$ isobar production in these channels is studied. It is found that the absorptive single-pion-exchange model cannot adequately explain all the features of simultaneous isobar production in these reactions. When the reactions $\bar{p}n \to (\bar{N}^{*-}N^{*+}$ or $\bar{N}^{*0}N^{*-}) \to \bar{p}\pi^+n\pi^-$ are compared with their counterpart $pp \to N^{*++}N^{*0} \to pp\pi^+\pi^-$, the former are found to be less peripheral than the latter, in sharp disagreement with a prediction of the model. A generalized single-pion-exchange model is discussed which gives better agreement with the nucleon-pion two-body mass and angular distributions. Some evidence for enhancements in the nucleon and antinucleon dipion systems at 1400 MeV is discussed. (auth)

45421 OBSERVATION OF TWO Ξ^-p ELASTIC-SCATTERING EVENTS. Dalmeijer, R. R. A. (Univ., Amsterdam); de Groot, A. J.; Kluyver, J. C.; de Lijser, E.; Tiecke, H. J. G. M. Lett. Nuovo Cim.; 4: 373-6(29 Aug 1970).

Two Ξ^- + p elastic scattering events were found from an exposure of a hydrogen bubble chamber to a 4.25 GeV/c K^- beam. The experiment is described, and the cross section is derived. (J.F.P.)

Strong (Meson-Induced)

Refer also to abstract 45532.

45422 (COO–1195-193) PARTIAL WAVE ANALYSIS OF THE 3π DECAY OF THE A_2. Ascoli, G.; Brockway, D. V.; Crawley, H. B.; Eisenstein, L. B.; Hanft, R. W.; Ioffredo, M. L.; Kruse, U. E. (Illinois Univ., Urbana. Dept. of Physics). Jun 1970. 13p. (CONF-700806-21). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

A new partial wave analysis is applied to the 3π decay of the A_2^- in the reaction $\pi^-p \to p\pi^+\pi^-\pi^-$ at 5 and 7.5 GeV/c. The relative importance of the spin parities 0^-, 1^+, 1^-, 2^+, and 2^- are obtained as a function of 3π mass. Only the 2^+ spin parity shows resonant structure. Results are also given on the polarization and momentum transfer dependence of the A_2 and on the mass dependence of the interference of 1^+ background with 2^+ resonance. (auth)

45423 (COO–1428-226) COHERENT Q-MESON PRODUCTION IN K^+d INTERACTIONS AT 9 GeV/c. Holland, R. F.; Carmony, D. D.; Clopp, H. W.; Cords, D.; Garfinkel, A. F.; Loeffler, F. J.; Rangan, L. K. (Purdue Univ., Lafayette, Ind.); Lander, R. L.; Pellett, D. E.; Yager, P. M. (California Univ., Davis). [1969]. 8p. (CONF-700806-31). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Results are presented on the production and decays of $K\pi\pi$ enhancements in the Q region. The analysis is based on roughly 40,000 three- and four-prong events measured in an exposure of 150,000 pictures (7 events/μb) in the Brookhaven 80" deuterium bubble chamber. The pertinent reactions are $K^+d \to Qd$, and $K^+d \to Qpn$, where $Q \to K^+\pi^+\pi^-$. (auth)

45424 (COO–1428-227) A_2 MESON PRODUCTION IN K^-d REACTIONS. Garfinkel, A. F.; Ammann, A. C.; Carmony, D. D. (Purdue Univ., Lafayette, Ind.); Yen, W. L. (Indiana-Purdue Univ., Indianapolis). [1970]. 14p. Dep. CFSTI.

A new interpretation of published data on the reaction $K^-n \rightarrow \Lambda^0 A_2^-$ is made which appears to make it compatible with a $J^{PC} = 2^{++}$ assignment for the A_2^- and hence with the simple quark model. New data on the reactions $K^-n \rightarrow \Lambda^0 A_2^-$ and $K^-n \rightarrow \Sigma^0 A_2^-$ are presented which are compatible with $J^{PC} = 2^{++}$ for the A_2^-. In addition, it appears that the A_2^- produced by kaons is narrow and has different branching ratios from the state throughly studied in pion induced reactions. (auth)

45425 (COO–1428-229) K(498)^0, K*(890)^0, AND K**(1420)^0 PRODUCTION IN K^+n INTERACTIONS AT 9.0 GeV/c. Clopp, H. W.; Carmony, D. D.; Cords, D.; Garfinkel, A. F.; Holland, R. F.; Loeffler, F. J.; Rangan, L. K. (Purdue Univ., Lafayette, Ind.); Lander, R. L.; Pellett, D. E.; Yager, P. M. (California Univ., Davis). [nd]. 11p. (CONF-700806–30). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

From a 150,000 picture (7 event/μb) K^+d exposure at 9.0 GeV/c in the BNL 80" bubble chamber 40,000 three- and four-prong events, 8,000 events of the one- to four-prong plus vee topology and several thousand selected two prongs were measured. The reaction $K^+n \rightarrow pK^+\pi^-$ is discussed including K*(890) production and decay. The observed pπ low-mass enhancement is discussed in terms of a double Regge exchange model. (auth)

45426 (COO-1428-230) PROPOSAL FOR AN EXPOSURE OF THE 15 FOOT DEUTERIUM FILLED BUBBLE CHAMBER TO A BEAM OF SEPARATED π^+ MESONS AT 40 GeV/c AT N.A.L. (Purdue Univ., Lafayette, Ind.). 21 Jul 1970 8p. Dep CFSTI.

The purpose of this experiment is twofold. Production mechanisms and properties of reactions are studied where there are an even number of visible pions and a visible nucleon in the final state. These reactions are used to obtain information on: G parity of high mass bosons, study of the multiperipheral chain in ππ scattering a la Amati-Fubini-Stanghellini and Chew-Goldberger-Low, study of the properties of Pomeron exchange in ππ scattering, test of the vector dominance model, spin parity determination of higher boson resonances, and a search for unexpected new phenomena. Concurrently a hybrid system is proposed. It is essential to understand the origin of possible biases in such a system. Since no experimental results exist in the 40 GeV region which has bearing on the ππN final state, it is essential to carry out a large statistics bias free inelastic πN scattering experiment. It is of interest to all counter and spark chamber groups who intend to study the ππN final state. A separated π^+ beam and a deuterium filled chamber are requested. On the order of 600,000 pictures are needed to obtain reasonable statistics, although this quantity may need modification depending on possible collaboration with other groups who have a comparable scanning or measuring facility. (auth)

45427 (ITEF–754) ELASTIC KN SCATTERING AND CHARGE EXCHANGES WHEN BRANCHINGS ARE TAKEN INTO ACCOUNT. Sukhorukov, S. T. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The analyses of the experimental data on $K^\pm N$ scattering and $K^-p \rightarrow \bar{K}^0 n$, $K^+n \rightarrow K^0 p$ charge exchange reactions are carried out in the framework of the complex angular momentum method. The branch points in j-plane are taken into account. Their contributions to the amplitudes of the processes are parametrized in a simple form which corresponds to the "optical" model of the successive rescatterings. Good agreement with the experiment is achieved in the region of the small momentum transfer. (auth)

45428 (UH–511-65-70) FEATURES OF THE REACTION $\pi^-p \rightarrow \pi^-\pi^-\pi^-\pi^+\pi^+p$ AT 3.9 GeV/c. Abe, K.; Johnson, A. D.; Stenger, V. J.; Wohlmut, P. G. (Hawaii Univ., Honolulu). Apr. 1970. Contract AT(04-3)-511. 18p. (CONF-700528-1). Dep. CFSTI.

From Colloquium on High Multiplicity Hadronic Interactions, Paris, France.

We present experimental data for 459 events of the reaction $\pi^-p \rightarrow \pi^-\pi^-\pi^-\pi^+\pi^+p$ at 3.9 GeV/c. The results are compared with a model of incoherent resonance production with constant production amplitudes. Little peripheralism is observed. Multiparticle correlation effects are seen which appear to result from a combination of Bose statistics and resonance reflections. (auth)

45429 PRODUCTION OF A POSITIVE PION IN A COLLISION OF A 247 MeV NEGATIVE PION WITH A PROTON. Blair, I. M. (CERN, Geneva); Mueller, H.; Torelli, G.; Zavattini, E.; Mandrioli, G. Phys. Lett.; 32B: 528-32 (17 Aug 1970).

The total cross section σ for the reaction $\pi^-p \rightarrow \pi^-\pi^+n$ was measured at 74 MeV over the threshold and σ = (60 ± 15) μb was found. The observed differential distributions in the Dalitz plot were analyzed with Gribov's formula obtaining $a_2 - a_0 = -(0.42 \pm 0.10)\ m_\pi^{-1}$. (auth)

45430 $K^\pm P$ ELASTIC SCATTERING AT 180° FROM 0.40 TO 0.73 GeV/c. Caldwell, Paul Kendall. Tucson, Ariz.; Univ. of Arizona (1969). 51p.

The $K^\pm p$ elastic scattering was measured in a small angular region near 180° ($-.995 \geq \cos\theta_{c.m.} \geq -1$) at momenta ranging from 0.4 to 0.73 GeV/c. The experiment detected the forward-scattering protons with scintillation counters. The $K^+ p$ data are used to compute the p-wave contributions to the scattering assuming s-wave dominance. The p-wave phase shift $(2\delta_{1+} + \delta_{1-})$ is found to be negative in the region 0.40 to 0.55 GeV/c. The $K^- p$ elastic differential cross-section is found to dip smoothly to a minimum (0± 0.2 mb/steradian) at 0.66 GeV/c. (Diss. Abstr. Int., B)

45431 π^-d INTERACTIONS AT 2.3 GeV/c. Benvenuti, Alberto. Minneapolis; Univ. of Minnesota (1969). 163p. Thesis.

The following reactions were studied: (1) $\pi^-d \rightarrow \pi^-p\ p_s$, (2) $\pi^-d \rightarrow \pi^-\pi^-\pi^0\ p\ p_s$, and (3) $\pi^-d \rightarrow \pi^-\pi^-\pi^+n\ p_s$. A strong isobar production at a mass of ≃1670 MeV/c^2 is observed in reaction 1. The spin and isospin of the isobar are determined; its production mechanism is found to be consistent with baryon exchange. The existence of isospin-two boson resonances is investigated but no evidence for the production of such resonances in the $\pi^-\pi^-$ and $\pi^-\rho^-$ systems is found. Reaction 3 is found to be dominated by the production of the $\Delta^-\rho^0$ and $\Delta^-\pi^-\pi^+$ final states. A study of the $n\pi^-\pi^-$ system gives evidence for the production of an isospin $^5/_2$ resonance with mass of 1645 MeV/c. The statistical significance of the observed effect is estimated to be five standard-deviations. (Diss. Abstr. Int. B)

45432 SIX-PRONG EVENTS IN π^-p INTERACTIONS AT 7.0 GeV/c. Campbell, James Edward. Blacksburg, Va.; Virginia Polytechnic Inst.(1969). 77p.

Thesis.

There were 2250 events studied with 6 charged tracks in the final state from 7.0 GeV/c π^-p film taken at the BNL 80-inch bubble chamber. The events were fitted to the final states (1) $\pi^-p \rightarrow \pi^-\pi^-\pi^-\pi^+\pi^+p$, 211 events; (2) $\pi^-p \rightarrow \pi^-\pi^-\pi^-\pi^+\pi^+p\pi^0$, 535 events; and (3) $\pi^-p \rightarrow \pi^-\pi^-\pi^-\pi^+\pi^+\pi^+n$, 230 events. The total six-prong cross section is found to be 2.40 ± 0.27 mb. The partial cross sections are: 0.22 ± 0.04 mb for reaction (1), 0.58 ± 0.09 mb for reaction (2), and 0.24 ± 0.05 mb for reaction (3). Final state (1) shows significant ρ(760) and Δ^{++}(1238) production. In reaction (2) there is Δ^{++}(1238) production and a bump at 1540 ± 20 MeV/c^2 with width 100 ± 40 MeV/c^2 in the $p\pi^0$ mass distribution (interpreted as N*(1520)). The $\pi^+\pi^-\pi^+\pi^-$ mass plot shows peaks at 1085 ± 20 MeV/c^2 and 1470 ± 20 MeV/c^2 with widths 70 ± 30 MeV/c^2 and 60 ± 25 MeV/c^2. These peaks appear less prominently in reaction (3). The transverse momentum distributions are analyzed in terms of statistical model predictions. In particular the Hagedorn statistical thermodynamical model gives temperatures of 120 MeV for pions and 150 MeV for nucleons. The influence of Bose-Einstein statistics as found by Goldhaber is observed in the angles between pion pairs. (Diss. Abstr. Int. B)

45433 RESONANCE STUDIES IN π^+p INTERACTIONS BETWEEN 3 AND 4 GeV/c. Jackson, Warren Carver. Riverside, Calif.; Univ. of California (1969). 103 p.

Thesis

Three resonance studies are described from a high statistics bubble chamber experiment on π^+p interactions at five incident momenta, 2.95, 3.19, 3.53, 3.74, and 4.08 GeV/c. A total of 39000 events with four charged outgoing particles were measured, of which 7300, 9300 and 2100 could be unambiguously constrained to the reactions: (1) $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$, (2) $\pi^+p \rightarrow \pi^+\pi^+\pi^-p\pi^0$, and (3) $\pi^+p \rightarrow \pi^+\pi^+\pi^+\pi^-n$. In reaction 2 the H enhancement, previously seen in the reaction $\pi^+p \rightarrow \Delta^{++}(1236)(\rho\pi)^0$, $(\rho\pi)^0 \rightarrow \pi^+\pi^-\pi^0$ was studied. It was concluded that the data on the H from this experiment, as well as from all previous ones, could be explained as a kinematic effect of the cuts used for ρ selection. In reaction 1 "cascade" decays of higher N*'s of the form $\pi^+p \rightarrow N^{*+}\pi^+$, $N^{*+} \rightarrow \Delta^{++}(1236)\pi^-$, $\Delta^{++}(1236) \rightarrow \pi^+p$ are studied. The N^{*+} could be any one of the large group with masses below 1700 NeV or the N* (1920), N* (2190) or N* (2420). Evidence is presented that the last two result partially from the s-channel formation reaction $\pi^+p \rightarrow \Delta^{++}(2850) \rightarrow N^{*+}\pi$. A number of other topics are studied. Among these is an exhaustive investigation of the events of reaction 3. A brief summary of these is also given. (Diss. Abstr. Int., B)

45434 K^-p CHARGE EXCHANGE AT 3.95 GeV/c. Moscoso, L. (CEN, Saclay, France); Hubbard, J. R.; Leveque, A.; Louedec, C.; Revel, D.; Badier, J.; Barrelet, E.; Makarovitsch, I.; Rouge, A.; Videau, H. Phys. Lett.; 32B: 513-14(17 Aug 1970).

The charge exchange reaction $K^-p \to \bar{K}^0n$ was studied in a 9 event/μb exposure of the CERN 2m hydrogen bubble chamber to a 3.95 GeV/c K^- beam. The differential cross section $d\sigma/dt$ exhibits a change of slope at $-t \approx 0.8$ GeV^2. (auth)

45435 PRODUCTION OF Ξ^- AND $\bar{\Xi}^+$ PARTICLES IN K^+p COLLISIONS AT 12.7 GeV/c. Stone, S. L.; Berlinghieri, J. C.; Bromberg, C.; Cohen, D.; Ferbel, T.; Holmes, R.; Slattery, P.; Werner, B.; Yuta, H. (Univ. of Rochester, N.Y.). Phys. Lett.; 32B: 515-18(17 Aug 1970).

The cross section for the production of $\bar{\Xi}^+$ particles in K^+p interactions at 12.7 GeV/c is 10 ± 3 μb; the Ξ^- production cross section is 2.5 ± 1.0 μb; the upper limit on Ω^- or Ω^+ production is 0.4 μb. The Ξ^- is produced preferentially in the backward direction in the CM system while the $\bar{\Xi}^+$ is produced mainly forward. The mass and lifetime of the $\bar{\Xi}^+$ agree with the accepted values for the Ξ^- hyperon. (auth)

45436 POMERANCHUK THEOREM AND THE SERPUKHOV DATA ON TOTAL CROSS SECTIONS. Eden, Richard J. (Univ. of California, Riverside). Contract AT(11-1)-68. Phys. Rev., D; 2: 529-31(1 Aug 1970).

The recent Serpukhov data for K^-p and earlier data for K^+p collisions appear to contradict the Pomeranchuk theorem on the asymptotic equality of particle-target and antiparticle-target total cross sections. Experimental and theoretical consequences of the invalidity of the Pomeranchuk theorem are discussed. These include the result that forward amplitudes for K^-p and K^+p become asymptotically real. (auth)

45437 STRANGE-PARTICLE PRODUCTION IN π^+d INTERACTIONS FROM 1.1 TO 2.4 GeV/c. Davies, Donald W.; Abolins, Maris A.; Dahl, Orin I.; Danburg, Jerome S.; Hoch, Paul L.; Kirz, Janos; Miller, Donald H.; Rader, Robert K. (Univ. of California, Berkeley). Phys. Rev., D; 2: 506-17(1 Aug. 1970).

The properties of strange-particle final states arising from reactions of 1.1- to 2.4-GeV/c π^+ mesons on deuterium were studied. Total cross sections on deuterium are presented and three reactions are analyzed in terms of the impulse model. Y*(1385) production dominates the $n\Lambda K^+\pi^+$ final state, and the reaction is described adequately near threshold by a magnetic dipole K* exchange model. The $n\Sigma^+K^0\pi^+$ final state is found to be primarily $n\Sigma^+K^{*+}$. Highly aligned ϕ's are produced in the reaction $\pi^+d \to ppK^+K^-$, along with A(1520). (auth)

45438 STRANGE-PARTICLE PRODUCTION 1.7-GeV/c π^+ ON PROTONS. Pan, Yu-li; Forman, Fred L.; Ko, Winston; Hagopian, Vasken; Selove, Walter (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 2: 449-62(1 Aug 1970).

The Princeton-Pennsylvania accelerator 15-in. hydrogen bubble chamber was used to investigate π^+p associated production at 1.7 GeV/c. Approximately 4000 events were found; about half of these were in the Σ^+K^+ channel. The $\Lambda K^+\pi^+$ channel dominates the remaining half of the data. Evidence is found for the existence of a T = 1 hyperon resonance at 1475 ± 15 MeV with a width of 30 ± 15 MeV in the $\Lambda K^+\pi^+$, $\Sigma^+K^+\pi^0$, $\Sigma^0K^+\pi^+$, and $pK^+\bar{K}^0$ channels. The cross sections of the strange-particle channels and the branching ratios of various resonances are also presented. (auth)

45439 PROPERTIES OF $\pi_N(980)$. Ammar, R. (Univ. of Kansas, Lawrence); Kropac, W.; Yarger, H.; (and others). Phys. Rev., D; 2: 430-9(1 Aug 1970).

Results are presented on the properties of $\pi_N(980)$, produced peripherally in the reaction $K^- + p \to Y_1^{*+}(1385) + \pi_N^-(980)$ with a cross section of 9 ± 3 μb at 5.5 GeV/c. A search was made for $\pi_N(980)$ production via the decay of a higher-mass resonance. The cross section for the reaction $K^- + p \to \Lambda + D^0(1285)$ at 5.5 GeV/c, with the subsequent decay $D^0 \to \pi_N(980) + =$, was <6 μb at the 70% confidence level. The mass and width of the $\pi_N(980)$ are 980 ± 10 and 80 ± 30 MeV, respectively. The dominant decay mode is $\pi\eta$, with the decay angular distribution having about a 10% probability of being isotropic. At the 70% confidence level, the branching ratio into $\pi\rho$ relative to $\pi\eta$ relative to $\pi\eta$ is <0.25, and the amount of any K^-K^0 enhancement near 1 GeV, normalized to the $\pi^-\eta$ signal from $\pi_N^-(980)$ decay, is <0.2. (auth)

45440 REACTION $\pi^+p \to p\pi^+\pi^+\pi^-\pi^0$ AT 18.5 GeV/c. Hones, M. J.; Cason, N. M.; Biswas, N. N.; Helland, J. A.; Kenney, V. P.; McGahan, J. T.; Poirier, J. A.; Sander, O. R.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 2: 827-38(1 Sep 1970).

The reaction $\pi^+p \to p\pi^+\pi^+\pi^-\pi^0$ was studied at an incident π^+ momentum of 18.5 GeV/c. This reaction is dominated by strong resonance production and low four-momentum transfer squared from the target to the outgoing proton. A large excess of events in the $\pi^+\pi^+\pi^-\pi^0$ effective-mass distribution in the region from 1.52 to 2.32 GeV is observed. This enhancement is attributed primarily to $p\rho^+\rho^0$ and $pA\pi$ final states. A study of angular distributions in the $p\rho^+\rho^0$ final state suggests the importance of a double-peripheral production mechanism for these events. (auth)

45441 OBSERVATION OF REGGE-POLE EFFECTS IN $\rho^0\Delta^{++}$ AND $\omega^0\Delta^{++}$ PRODUCTION AT 3.7 GeV/c. Abrams, G. S.; Barnham, K. W. J.; Butler, W. R.; Coyne, D. G.; Goldhaber, G.; Hall, B. H.; MacNaughton, J. (Univ. of California, Berkeley). Phys. Rev. Lett.; 25: 617-21(31 Aug 1970).

Evidence is presented for zeros in the π-exchange contribution to $\rho^0\Delta^{++}$ and in the ρ-exchange contribution to $\omega^0\Delta^{++}$ production. The position of the π-exchange zero is consistent with a π trajectory with $\alpha'_\pi(0) \approx 1.2$ (GeV/c)$^{-2}$. Evidence is also presented suggesting that the A_2 chooses the Gell–Mann mechanism (nonsense choosing). A model of π exchange with exact π-B exchange degeneracy is found to describe the data quantitatively. (auth)

45442 EXPERIMENTAL STUDY OF $\pi^- + p \to \pi^- + N^*$ AT 8 AND 16 GeV/c. Anderson, E. W. (Brookhaven National Lab., Upton, N. Y.); Bieser, E. J.; Blieden, H. R.; (and others). Phys. Rev. Lett.; 25: 699-704(7 Sep 1970).

The cross section $d\sigma/dt$ was measured for five N* reactions in the process $\pi^- + p \to n^- + N^*$ at incident momenta of 8 and 16 GeV/c in the range of $|t| < 1.5$ (GeV/c)^2. N* bumps are observed at masses of 1.24, 1.41, 1.52, 1.69, and 2.19 GeV. Considerable structure is apparent in the $d\sigma/dt$ distributions including leveling off for $|t| < 0.15$ and dips at larger t in both the N*(1.24) and N*(1.52) reactions. The logarithmic slopes for the four higher mass N*'s are identical to those seen in the corresponding reaction in pp scattering and the cross sections exhibit a similar elasticlike behavior with incident energy. (auth)

45443 CORRELATION BETWEEN TRANSVERSE AND LONGITUDINAL MOMENTA OF SECONDARIES IN 8 GeV/c π^+ p INTERACTIONS. Balea, E.; Balea, O.; Mihul, A.; Sabu, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 233-6(1970).

The correlation between the mean transverse momentum and the c.m.s. longitudinal momentum of secondaries (π, K, p, Λ) was analyzed in 8-GeV/c π^+p interactions. The results are compared with the phase-space predictions and a new parameter to characterize the interaction is introduced. (auth)

45444 CROSS SECTIONS OF STRANGE-PARTICLE PRODUCTION IN π^+p INTERACTIONS AT 8 GeV/c. Balea, E.; Balea, O.; Mihul, A.; Sabau, M.; Sahini, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 407-9(1970).

The cross sections for strange-particle production in four-prong interactions of positive pions with protons are presented. The studied events were produced by a secondary beam of positive pions at 8.04 GeV/c interacting in a hydrogen bubble chamber. The cross section values and the number of events considered in each channel are listed. The total cross section for associated production channels was found to be 0.825 ± 0.131 μb. (J.F.P.)

45445 CROSS-SECTIONS OF STRANGE PARTICLES PRODUCTION IN π^-p INTERACTIONS AT 20 GeV. Balea, E.; Balea, O.; Coca, C.; Mihul, A.; Sabau, M.; Sahini, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 587-91 (1970).

An analysis is performed on the strange particles production cross sections in π^-p interactions at 20 GeV. (auth)

Particle Interactions and Properties (Theoretical)

General

45446 (DESY-70/29) PROBLEM OF THREE INTERACTING PARTICLES INCLUDING BOUND STATES. Kudlek, Manfred (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jul 1970. 35p. (In German). Dep. CFSTI (U. S. Sales Only).

A system of three interacting particles including bound states is considered. Annihilation or creation of particles are neglected. A representation space is constructed to give a consistent description of this system. Integral representations for the scattering operators of this many-body problem are deduced. Relations between different Lorentz frames are given for the transition operators, as well as between the 2-particle and 3-particle space. Finally it is shown how Faddeev equations have to be used. (auth)

45447 STATISTICAL BASIS FOR THE MANY-BODY MODEL OF MATTER. Collins, R. E. (Univ. of Houston, Tex.). Phys. Rev., D; 2: 658-66(15 Aug 1970).

The premise that physical variables must be treated as random variables is shown to yield a purely statistical basis for the many-body model of matter in both classical and quantum forms. This derivation also yields an alternative to the conventional quantum formalism in which the usual distinction between bosons and fermions does not appear. (auth)

45448 NODAL STRUCTURE, NODAL FLUX FIELDS, AND FLUX QUANTIZATION IN STATIONARY QUANTUM STATES. Riess, J. (Univ. of British Columbia, Vancouver). Phys. Rev., D; 2: 647-53(15 Aug 1970).

The nodal structure of the Schrödinger wave function is used to describe an N-particle system in a stationary quantum state. In terms of nodal lines (quantized flux lines) together with their circulation numbers, two fields are defined: the microscopic, singular nodal flux field n(r) and the macroscopic, regular nodal flux density field N(r). Their definition arises in a natural way from a quantum-mechanical vector potential defined by the gradient of the multivalued phase function associated with the pattern of quantized flux lines. The flux of the fields n(r) and N(r) is quantized and shown to be proportional to the circulation of the velocity in the system. The unit circulation for a system of bosons with a particle spin s = 0 and mass m_0 is equal to h/m_0. In the case of charged particles, the field $(c/q)N(r)$ resembles Jehle's formulation of the magnetic field of a lepton as a superposition of quantized flux lines. In our case, however, the presence of quantized flux lines, forming closed loops follows from the mere existence of a current density and does not have to be assumed. By a simple argument, using permutation symmetry, it is shown that a flux quantum of the size $hc/2q$ is possible. (auth)

45449 THEORY OF CURRENTS WITHOUT TOO MUCH SYMMETRY. Ahmed, M. A. (Univ. of Khartoum, Sudan). Nuovo Cim.; 69A: 47-56(1 Sep 1970).

A theory of currents due to Cronin and Guralnik is extended to allow for nonconservation of the axial vector current. This is achieved by enlarging the set of independent dynamical variables to include beside the vector and axial vector currents, the divergences of the axial currents and adding an extra term to their expression for the energy-momentum tensor. A series solution is obtained for the commutator at equal times between the time component of the axial vector current and a divergence that is seen to contain I = 0 as well as I = 2 terms. (auth)

45450 GENERAL METHODS FOR INTEGRATING THE RELATIVISTIC EQUATION OF SPIN MOTION, AND THEIR APPLICATION TO SOME CASES OF EXPERIMENTAL INTEREST. Fierz, M. (Eidgenoessische Technische Hochschule, Zurich); Telegdi, V. L. pp 106-208 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

Some general methods of solving the relativistic equation of spin motion in a succession of rest frames (R) are discussed. The methods are applied to derive the spin motion in some proposed experimental arrangement. It is found that all the useful frames are automatically rest-frames, thus the results are easily amenable to intuitive interpretation. (L.B.S.)

45451 EQUALITY OF THE TOTAL CROSS SECTIONS FOR THE INTERACTION OF PARTICLES AND ANTIPARTICLES AT HIGH ENERGY. Volkov, G. G.; Logunov, A. A.; Mestvirishvili, M. A. Teor. Mat. Fiz.; 4: 196-201(Aug 1970).

The physical conditions of violation as well as fulfilment of the Pomeranchuk theorem are presented. (auth)

45452 GENERALIZING THE DIRAC EQUATION. Ionescu-Pallas, N. J. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 397-401(1970).

A generalization of the Dirac quadratic equation is given. It refers to a particle of arbitrary spin submitted to vectorial and scalar interactions. The particle exhibits dipole and quadrupole properties with respect to both interactions. (auth)

Electromagnetic

Refer also to abstracts 44955, 45558, 45561, 45588, and 45592.

45453 TOPICS IN CURRENT ALGEBRA AND ELECTROMAGNETIC INTERACTIONS. Rabl, Arnulf. Berkeley, Calif.; Univ. of California (1969). 45p.

Thesis.

As a first step towards solving Sugawara's theory of currents the possibility that certain spectral sums might be dominated by a single-particle state is explored. The equations of motion for the currents are sandwiched between single-particle states and the bilinear current terms are evaluated by inserting a complete set of intermediate states. By approximating the intermediate states by single-particle states nonlinear equations for the form factors can be derived. When this method is applied to the energy momentum tensor lower bounds are found for the particle masses in terms of their form factors. By use of Reggeology and the Cottingham formula, the divergences of electromagnetic mass differences are isolated in Minkowski space. Sum rules are derived which are necessary and sufficient to cancel them; they also turn out to be the necessary and sufficient conditions for the Wick rotation to Euclidean space via $q_0 \rightarrow iq_0$. Bjorken's argument for logarithmic divergences due to current algebra is extended to the case where subtractions are needed in the dispersion relations. The Feynman–Dyson perturbation theory is applied to Schwinger's model of the monopole. The propagator for photon exchange between electric and magnetic charges is found. (TSS) (Diss. Abstr. Int. B)

45454 $\pi-\alpha$ SCATTERING AND THE PION FORM FACTOR. Fainberg, Michael Anthony. Berkeley, Calif.; Univ. of California (1969). 71 p.

Thesis.

A measurement of the $\pi^{\pm}$ ^{4}He scattering was made at 53, 60, 68, and 75 MeV incident pion lab energy. The resulting differential cross sections are presented. An attempt was made to extract the pion electromagnetic form factor using the difference in the π^+ and π^- cross sections which is sensitive to the Coulomb contribution to the total scattering amplitude. An optical model potential was postulated for the nuclear part of the interaction. Various different methods were used to extract the form factor, with a view to minimizing model dependence. The most detailed model available, using a method of analysis designed to reduce this dependence, gives R = 2.96 ± 0.43F. Possible uncertainties in the model and its application are also discussed. (Diss. Abstr. Int., B)

45455 COMMENT ON SCALE INVARIANCE OF INELASTIC ELECTRON–PROTON SCATTERING IN A MULTIPERIPHERAL MODEL WITH SCALAR COUPLINGS. Jones, S. T.; Wyld, H. W. Jr. (Univ. of Illinois, Urbana). Phys. Rev., D; 2: 949-51 (1 Sep 1970).

The form factor νW_2 for inelastic electron-proton scattering is numerically evaluated in a multiperipheral model with scalar couplings. It is found that although the model is theoretically scale invariant in the sense that νW_2 approaches a finite limit as $q^2 \rightarrow \infty$, this limit is approached very slowly; for values of $q^2 \sim 1$-7 $(GeV/c)^2$, experimentally attainable at SLAC, the model has not reached its scale-invariant limit. (auth)

45456 FIXED POLES IN HIGH-ENERGY COMPTON SCATTERING, ELECTROPRODUCTION, AND THE VECTOR-DOMINANCE MODELS. Mueller, A. H.; Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 2: 953-5 (1 Sep 1970).

It is shown that the vector dominance of s-channel helicity amplitudes requires the existence of a nonsense wrong-signature fixed pole at J = 1 in virtual photon-hadron scattering. Furthermore, in the amplitudes for electroproduction, where the virtual photon masses are spacelike, it is argued that such fixed poles must exist simply from such general requirements as analyticity, gauge invariance, and positivity of cross sections. This fixed pole occurs multiplicatively with the Pomeranchuk pole if the photon-hadron cross sections σ_L or σ_S are constant asymptotically with energy. A minimal amount of analyticity then allows one to extend this result to general values of the virtual photon masses. If the asymptotic cross section for photoproduction of ρ mesons is dominated by Pomeranchuk exchange and if it conserves helicity, then the multiplicative fixed pole is present there, too. Further, the presence of this fixed pole tests for the compositeness of the ρ meson or third-double-spectral-function effects. (auth)

45457 COHERENT NUCLEAR PHOTOPRODUCTION OF THE η-MESON. Benfatto, G. (Univ., Rome). Nuovo Cim.; 69A: 102-14(1 Sep 1970).

A critical review is given of some of the theoretical assumptions, which have recently allowed a Bonn–Pisa collaboration to extract the rate $\Gamma(\eta \rightarrow 2\gamma)$ from the analysis of the experimental data on η photoproduction on complex nuclei. In particular the two following subjects are studied: a) the effect of γ absorption in the nucleus on the coherent nuclear cross-section angular dependence, in agreement with some recent results, both theoretical and experimental; b) the estimate of the overall magnitude of the coherent nuclear contribution. It is concluded that it would be useful to reanalyze the experimental data, following the suggestions of this work. It is hoped that it is possible, in that manner, to explain the

very bad disagreement between the measured value of $\Gamma(\eta \to 2\gamma)$ and the predictions of most theoretical models. (auth)

45458 GEOMETRICAL INTERPRETATION OF SCALE INVARIANCE. Ferrara, S. (CNEN, Frascati, Italy); Rossi, G. Lett. Nuovo Cim.; 4: 408-12(29 Aug 1970).

A possible geometrical interpretation of scale invariance in inelastic e + p scattering is given starting from the observation that an external Lorentz group acts in a natural way on the functions of two complex variables leading to the same consequences. (J.F.P.)

45459 DIAGONAL AND NONDIAGONAL ELECTROMAGNETIC INTERACTIONS IN COLLIDING-BEAM EXPERIMENTS. Lipmanov, E. M. (Volgograd Pedagogical Inst., USSR). JETP Lett. (USSR) (Engl. Transl.); 11: 315-18(5 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 462-6(5 May 1970).

Arguments indicating the possibility of an appreciable physical difference between diagonal and nondiagonal interaction of weak currents were advanced by Gell-Mann et al. Certain physical consequences of the proposed separation into diagonal and nondiagonal interactions are considered in the case of interactions of leptonic electromagnetic currents. It is noted that the discovery of the effect of diagonalization, if it exists and is general, can be expected not only in neutrino experiments but also in high-energy colliding-beam experiments now in progress, provided "violations" of quantum electrodynamics are observed. (L.B.S.)

45460 ELEMENTARY DERIVATION OF GENERAL MULTIPOLE MOMENTS FOR A CLASSICAL CHARGE AND CURRENT DISTRIBUTION. Kemmer, N. (Univ. of Edinburgh). pp 1-12 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

It is shown that the problem of expressing the electric and magnetic 2^l-moments can be solved by quite elementary methods without the restrictions of previous works. The procedure follows closely the familiar lines from the theory of static fields and shows directly how the effective electric and magnetic 2^l-moments are related to the corresponding moments of static theory. An additional feature stressed is that the expressions obtained are equally valid for entirely continuous charge-current distributions and for those involving surface discontinuities. (L.B.S.)

45461 CURRENT PROPAGATOR AND HADRON PRODUCTION IN ELECTRON–POSITRON COLLISIONS. Sakurai, J. J. (Univ. of Chicago). pp 247-59 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

It is shown how the properties of the current propagator can be explored in detail by performing electron-positron colliding beam experiments. In particular it is demonstrated that precise measurements of the hadronic cross section in electron-positron collisions may answer questions concerning the q^2 behavior of the current propagator; the hadronic contribution to $(g - 2)$ for the muon; the hadronic contribution to charge renormalization; the magnitude of the Schwinger term; and the "bare mass" of the rho meson. (L.B.S.)

45462 SPATIAL EXTENT OF MAGNETIC MONOPOLES. Goebel, C. J. (Univ. of Wisconsin, Madison). pp 338-44 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

It is argued that a monopole must be as large as its classical radius $r_m = 137\ M^{-1}$. This is shown in a self-consistent model in which there are only monopoles and photons. An estimate is also made of the mass of the monopole. (L.B.S.)

45463 POSSIBLE TESTS OF ANOMALOUSLY LARGE LEPTONIC WEAK INTERACTIONS IN HIGH-ENERGY e^+e^- COLLISONS. Kinoshita, Toichiro; Pestieau, Jean; Roy, Probir; Terazawa, Hidezumi (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 2: 910-18(1 Sep 1970).

Some consequences of two possible mechanisms of a breakdown in V–A theory leading to anomalously large weak vertices in hitherto untested leptonic reactions are discussed. The processes $e^+e^- \to \mu^+\mu^-$ and $e^+e^- \to \nu_e \bar{\nu}_e \gamma$ with total c.m. energies around 10 GeV are considered. A purely leptonic neutral current can cause a measurable forward-backward muon asymmetry and a muon polarization in the first reaction. Expressions are computed for these effects in terms of the most general nonderivative coupling. On the other hand, some intrinsic anomaly in diagonal weak vertices can make the cross section for the second process large and measurable; in that case, study of the γ spectrum can reveal information about the structure of such an anomalous vertex. The angular distribution and the energy spectrum of the photon are computed for the V–A and S–P theories up to terms that are first order in (total c.m. energy)^2/2(intermediate-boson mass)^2. (auth)

45464 BROKEN CHIRAL SYMMETRY AND THE η MESON. Fujii, Yasunori (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 2: 896-901(1 Sep 1970).

The scheme of broken chiral symmetry given by Gell-Mann, Oakes, and Renner is generalized to include the η meson with proper consideration of the octet-singlet mixing. It is shown that at least one of the η and the η' must violate the partially conserved axial-vector current (PCAC) condition (or Adler's condition). This is not simply because they are much heavier than the pion. The analysis of the decays $\eta \to 3\pi$ and $\eta \to 2\gamma$, which are known for large deviations from the simple SU_3 predictions, indicates that PCAC for the η is violated rather severely. (auth)

45465 UP–DOWN ASYMMETRY IN INELASTIC ELECTRON–POLARIZED-PROTON SCATTERING. Cahn, Robert N. (Univ. of California, Berkeley); Tsai, Y. S. Phys. Rev., D; 2: 870-6(1 Sep 1970).

The up-down asymmetry in inelastic electron scattering from polarized protons was investigated. It is shown that the contributions from (possible) T violation and α^3 effects can be separated experimentally. It is demonstrated that the contribution of bremsstrahlung emission to the asymmetry is negligible. An expression for the two-photon-exchange contribution is obtained, assuming a proton intermediate state and N*(1238) final state. The expression was evaluated numerically and found to be one order of magnitude smaller than the observed asymmetry. A general formalism for calculating the up-down asymmetry is presented and its physical significance discussed. The relation between T violation and the measurement of the asymmetry given by Christ and Lee is sharpened and the experimental results of the Berkeley-SLAC collaboration are discussed. (auth)

45466 SUPEREIKONAL MODEL OF DEEP-INELASTIC ELECTRON–PROTON SCATTERING. Fried, H. M.; Moreno, Hector (Brown Univ., Providence). Phys. Rev. Lett.; 25: 625-8(31 Aug 1970). (NYO–2262TA-221).

A field-theoretic model is written to describe the structure function W_2 of deep-inelastic e-p scattering. Strict Bjorken scaling is found not to hold; nevertheless, the model provides a modest fit to the experimental data. A variant of the Drell-Yan-West relation between the elastic limit of W_2 and the asymptotic falloff of the electromagnetic form factors is obtained. (auth)

45467 ESTIMATE OF THE HADRONIC CONTRIBUTION TO CHARGE RENORMALIZATION FROM SCALE INVARIANCE. Etim, E. (Univ., Naples); Picchi, P. Lett. Nuovo Cim.; 4: 368-72(29 Aug 1970).

It is shown how normalization conditions can be used to estimate the hadronic corrections to charge renormalization using as input the hadronic contribution to the muon g-factor. (J.F.P.)

45468 MAGNETIC MOMENT OF THE RELATIVISTIC COMPOSITE SYSTEM. Faustov, R. (Univ., Turin). Nuovo Cim.; 69A: 37-46(1 Sep 1970).

The relativistic corrections to the magnetic moment of the loosely bound composite system of particles are considered within the framework of the three-dimensional quasi-potential method. Particular attention is paid to the corrections connected with recoil of the system as a whole. (auth)

45469 PRINCIPLE FOR ACCELERATING CHARGED PARTICLES BY ac FIELDS WITHOUT PHASE RELATION BETWEEN FIELD AND INCOMING PARTICLE OR ACCELERATION CYCLE. Daniel, H. (Technische Hochschule, Munich). Z. Phys.; 236: 166-9(1970). (In German).

A principle for accelerating charged particles by ac fields without phase relation between field and incoming particle or acceleration cycle is sketched. It is based on transverse deflection of the particle according to the ac phase and time-of-flight differences in electrodes of opposite voltages. (auth)

45470 PHASE EQUATION FOR THE SCATTERING LENGTH OF A MODIFIED COULOMB POTENTIAL. Ronveaux, A. (Facultes Universitaires Notre-Dame de la Paix, Namur, Belgium). Lett. Nuovo Cim.; 4: 464-5(5 Sep 1970).

An alternate definition to the effective range theory for the Coulomb scattering length is used as a starting point for the phase approach. The zero-energy Schroedinger equation for a repulsive Coulomb potential modified by a short-range nuclear potential is considered. This should prove to be of some interest in pp and $\alpha\alpha$ scattering. (J.F.P.)

45471 PARTON MODEL WITH POISSON DISTRIBUTION FOR INELASTIC LEPTON–NUCLEON SCATTERING. Kitani, K.;

Yoshii, H. (Tokyo Inst. of Tech.). Lett. Nuovo Cim.; 4: 431-5 (5 Sep 1970).

A new model of nucleon structure from the standpoint of the parton theory is proposed. It is found that the parton is a quark-like constituent, the parton distribution is approximately Poissonian, and one-dimensional phase-space $f_N(x)$ works well at $x \gtrsim 0.1$. (J.F.P.)

Weak

Refer also to abstracts 44840, 44849, 45463, 45560, and 45599.

45472 CALCULATION OF $K_2^0 \rightarrow 2\gamma$ DECAY RATE. Wong, N. N. (Univ. of Alberta, Edmonton). Phys. Rev., D; 2: 625-6 (1 Aug 1970).

The decay rate of $K_2^0 \rightarrow \gamma\gamma$ is calculated by relating the amplitude for $K_2^0 \rightarrow \gamma\gamma$ to that for $K \rightarrow 3\pi$, where the Veneziano model is assumed for the latter. (auth)

45473 CORRECTIONS TO THE SOFT-PION THEOREM IN K_{l3} DECAY. Mathur, V. S.; Okubo, S. (Univ. of Rochester, N.Y.). Phys. Rev., D; 2: 619-20(1 Aug 1970).

Using appropriate continuity arguments in the $SU^{(+)}(3) \otimes SU^{(-)}(3)$ subgroup space, a new sum rule was derived for K_{l3} decays. This sum rule incorporates corrections to the soft-pion theorem and contains K_{l3} form factors defined at a point much closer to the physical decay region. (auth)

45474 HIGH-ENERGY BEHAVIOR OF LOWEST-ORDER WEAK AMPLITUDES WITH ELECTROMAGNETIC RADIATIVE CORRECTIONS. Li, L. F. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 2: 614-16(1 Aug 1970).

The electromagnetic radiative corrections at high energy to the lowest-order weak amplitudes $\nu_\mu + \bar{\nu}_e \rightarrow \mu^- + e^+$ and $\nu_\mu + e^- \rightarrow \mu^- + \nu_e$ were examined by an approximate method. (auth)

45475 CURRENT ALGEBRA, K_{l3}^0 FORM FACTORS AND RADIATIVE $\bar{K}_{l3}^0$ DECAY. Fearing, Harold W. (State Univ. of New York, Stony Brook); Fischbach, Ephraim; Smith, Jack. Contract AT(30-1)-3668B. Phys. Rev., D; 2: 542-60(1 Aug 1970).

The complete gauge-invariant matrix element for the decays $\bar{K}^0 \rightarrow \pi^+ l^- \bar{\nu}\gamma$ (l = e or μ) is derived using the soft-photon theorems of Low and of Adler and Dothan. These theorems, along with several corollaries of them, are reviewed in detail and their application demonstrated by reference to the radiative $\bar{K}_{l3}^0$ decay mode. The square of the matrix element is calculated using the theorem of Burnett and Kroll, and is compared with the result of a direct computer evaluation of the appropriate traces. Structure-dependent terms are discussed, and the dominant terms among those linear in the photon energy are estimated in the soft-pion and kaon limits. Results for the radiative photon spectra are given, together with the decay rates for a specific value of the minimum photon energy E_0. (auth)

45476 CHIMERON MODEL OF THE INTERMEDIATE VECTOR BOSON W. Tuan, S. F. (Univ. of Hawaii, Honolulu). Contract AT(04-3)-511. Ann. Phys. (N. Y.); 59: 80-108(Jul 1970).

It is proposed to mediate the weak interactions with charged vector bosons which are given strong pair-wise interactions with the hadrons (coupling $f \sim 1$), and which are identified with the "a" particles of T. D. Lee—these are particles having nonvanishing charge Q_K corresponding to the $C_{\pi\pi}$-even part of the electromagnetic current. A mismatch model of Lee is adapted to illustrate the prominent features of the $W^\pm \equiv a^\pm$ "Chimeron" theory in the limit that the strong interactions are SU(3) conserving. It is shown that a relatively stringent additional constraint is needed to make the $f \sim 1$ type Chimeron theory viable. The pattern of mismatch which leads to CP nonconservation when SU(3) breaking and electromagnetic interactions are introduced, is considered. An alternative W ≡ a model proposed by Okun and Rubbia which employs universal definition of C, P, T without SU(3) symmetry is also presented and shown to lead to very different empirical consequences; in particular the pair-wise coupling f or the a-fields to normal hadrons must now be reduced to $10^{-2} - 10^{-3}$. Finally the experimental implications of the strong ($f \sim 1$) $W^\pm \equiv a^\pm$ theory are discussed. (auth)

45477 SUM RULE FOR NONLEPTONIC HYPERON DECAY. Tomozawa, Y. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 32B: 485-9(17 Aug 1970).

A simple rule is derived which relates the p-wave amplitudes to those of the s-wave of the nonleptonic hyperon decay. (auth)

45478 K_{l3} DECAY: EXPERIMENTAL RESULTS AND COMPARISON WITH THEORY. Chounet, L. M. (Laboratoire de l'Accelerateur Lineaire, Orsay, France); Gaillard, M. K. Phys. Lett.; 32B: 505-9(17 Aug 1970).

The results of a recent compilation of experimental data on K_{l3} form factors are presented and compared with the predictions of current algebra. (auth)

45479 UNITARITY BOUNDS TO T-ODD CORRELATIONS IN NEUTRINO REACTIONS. de Rujula, A.; de Rafael, E. (CERN, Geneva). Phys. Lett.; 32B: 495-8(17 Aug 1970).

Rigorous bounds, to order $\alpha \simeq 1/137$, are derived in elastic neutrino reactions for the outgoing lepton or hadron transverse polarization induced by the final state interactions. (auth)

45480 RATE OF ENERGY LOSS AND SEA-LEVEL SPECTRUM OF MUONS ABOVE 1000 GeV. Kiraly, P.; Wolfendale, A. W. (Univ. of Durham, Eng.). Phys. Lett.; 32B: 510-12(17 Aug 1970).

It is demonstrated that the recent suggestion of Bergeson et al. (1968) of muons produced by a new process—the X-process—does not necessarily demand an increase in the photonuclear cross section. (auth)

45481 CONCERNING ONE POSSIBILITY OF MEASURING THE REGENERATION PHASE. Margvelashvili, P. I. (Tbilisi State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 11: 307-8(5 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 452-4(5 May 1970).

A proposal is made to use, for a direct observation of the regeneration phase, the interference between beams of long-lived neutral K mesons, one attenuated and the other coherently regenerated from K_1^0. An advantage given for the proposed experiment in that there is no need to plot the interference cure, and that it is sufficient to measure the intensities of the $K_2^0 \rightarrow 3\pi$ decays. (L.B.S.)

45482 TESTS OF THE V–A THEORY IN NEUTRINO–LEPTON INTERACTIONS. Jarlskog, C. (Univ. of Lund, Sweden). Lett. Nuovo Cim.; 4: 377-80(29 Aug 1970).

Tests of the V–A theory from cross sections for $\bar{\nu}_e + e^- \rightarrow \bar{\nu}_\mu + \mu^-$, $\nu_\mu + e^- \rightarrow \nu_e + \mu^-$ and $\nu_e + e^- \rightarrow \nu_e + e^-$ and $\bar{\nu}_e + e^- \rightarrow \bar{\nu}_e + e^-$ interactions are discussed. (J.F.P.)

45483 WEAK PROCESS $\pi^+P \rightarrow K^+P$. Kolanowski, M. (Univ. of Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 18: 345-8(1970).

A pole model description is used to study the weak process $\pi^+ + p \rightarrow K^+ + p$ in the low-energy region. An estimate is obtained for the cross-section ratio of the weak and elastic process. (L.B.S.)

45484 MESON AND BARYON SEMILEPTONIC DECAYS. Mainland, G. B.; Boehm, A. (Univ. of texas, Austin). Phys. Rev., D; 2: 919-21(1 Sep 1970).

In analogy with the conserved-vector-current hypothesis, the weak-interaction currents are postulated to be equal to commutators involving the generators of SL(3,C) [SU(3) × SU(3)] and the isospin component of the electromagnetic current. Three meson semileptonic decay rates are calculated in terms of no new constants, and six baryon decay rates and six values of the quantity gA/gV are calculated in terms of two SL(3,C) reduced matrix elements. The predicted decay rates and values of gA/gV are in good agreement with experimental values. (auth)

45485 DEPENDENCE OF NEUTRINO–NUCLEUS CROSS SECTIONS ON THE MASS NUMBER. Trefil, J. S. (Univ. of Illinois, Urbana). Phys. Rev., D; 2: 843-5(1 Sep 1970).

The dependence of the ν-nucleus total cross section is discussed, and it is shown that an energy-dependent transition between $\sigma_{\nu A} \propto A$ and $\sigma_{\nu A} \propto A^{\frac{1}{3}}$ should be expected on the basis of the multiple-scattering series. Comparison with data is made. (auth)

45486 κ-MESON AND THE SCALAR FORM FACTOR IN K_{l3} DECAY. Bandelloni, G. (Univ., Genoa); Eberle, E. Lett. Nuovo Cim.; 4: 416-20(5 Sep 1970).

The relation between the $K \rightarrow \pi + l + \nu$ decay parameters and the mass and width of the scalar strange κ meson is considered in the framework of the SU(3) × SU(3) algebra of charges. (J.F.P.)

45487 WEAK INTERACTIONS AT HIGH ENERGIES. von Gehlen, G. (Univ., Bonn). Ergeb. Exakten Naturwiss.; 53: 29-44(1970).

Weak interactions by which deviations from the interaction Hamiltonian density may be detected are considered. The intermediate vector boson theory, production of W in neutrino experiments, two neutrino hypothesis, and violation of unitarity in lowest order weak interactions are discussed. Also considered are tests of the locality of the lepton interaction, the decay $K_2 \rightarrow$

μ^+ and μ^- in the second order weak interaction, and estimates of the weak interaction cut-off. (J.F.P.)

45488 S-MATRIX THEORY OF WEAK INTERACTIONS. Barut, A. O. (Univ. of Colorado, Boulder). Ergeb. Exakten Naturwiss.; 53: 1-5(1970).

Leptonic weak interactions are discussed. The kinematical approach of Fermi is continued. Taking the form of the interaction Lagrangian not as a Lagrangian but as the kinematical basis function of the amplitude itself, it is shown that under very general conditions the scalar amplitude for the process must be a decreasing function of the energy and momentum transfer at least as fast as 1/(s log s). (J.F.P.)

45489 COVARIANT SPIN DENSITY MATRIX FORMALISM FOR INELASTIC SCATTERING OF POLARIZED LEPTONS. Fraas, H. (Univ., Wuezburg, Ger.). Z. Phys.; 234: 472-8 (1970).

Starting from a generalization of helicity to the case of spacelike momenta the spin density operator for the virtual photon in inelastic scattering of polarized, massive leptons is given. (auth)

Strong (General)

45490 (COO-264-556) QUARK FOCUSING AT HADRONIC VERTICES. Frampton, Paul H.; Freund, Peter G. O. (Chicago Univ., Ill.). Aug 1970. Contract AT(11-1)-264. 29p. (EFI-70-44). Dep. CFSTI.

A basis for a dual theory of processes that involve external and/or intermediate exotic hadrons is found in the form of a quark focusing principle. This principle, derived from the conformal invariance of the theory, requires that at a hadronic vertex all active quarks be focused to a point of their world sheet and act together (as a point-like particle) in the transfer of momentum. It is found that all hadronic couplings (including the coupling of any three exotic hadrons) can be expressed in terms of a single (say the $p\pi\pi$-) coupling constant. Applications to $B\bar{B}$- scattering are made. (auth)

45491 (IC-70/76) ASYMPTOTIC SYMMETRIES AND HADRON SYSTEM. Oneda, S.; Matsuda, Seisaku (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1970. 20p. Dep. CFSTI (U. S. Sales Only).

Formulation of an idea of asymptotic SU(3) and SU(2) symmetries which are compatible with the Gell-Mann-Okubo (G-M-O) and the SU(2) mass splittings (including mixings) is discussed. Consequences of the application of these asymptotic symmetries so far obtained are briefly reviewed. Combined with the use of suitable equal-time commutation relations involving the generators of these groups and also their time derivatives, these asymptotic symmetries require that there exist rather simple SU(3) and SU(2) inter-multiplet regularities among the mass spectra of hadrons. Broken SU(3) and SU(2) sum rules obtained by using asymptotic symmetries exhibit simple but sometimes very significant modifications of exact-SU(3) and exact-SU(2) sum rules through the appearance of the physical masses and the mixing parameters in the sum rules. (auth)

45492 (IC-70/89) INVESTIGATION OF SOME DUAL AMPLITUDES WITH CUTS. Abo-Shaeer, Muhsin A. R. (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1970. 16p. Dep. CFSTI (U. S. Sales Only).

Two simple ways of adding an infinite number of direct channel two-particle thresholds to the Veneziano picture, which usually contains only resonances in the direct channel, are studied. The high-energy behavior, positivity, and l-plane structure of the resulting amplitudes, which turn out to have Regge cuts in addition to Regge poles in the crossed channel, are investigated. (auth)

45493 STRONG INTERATIONS OF ELEMENTARY PARTICLES. Eden, R. J. (Cambridge Univ., Eng.). Essays Phys.; 1: 1-32(1970).

Properties and theories of the interactions of baryons and mesons are considered. As some properties are related to their electromagnetic and weak interactions, leptons are also discussed. Elementary particles are classified into groups by their properties. Resonances are considered and the application of group theory to symmetries discussed. Experiments on collision processes are related to S matrix elements or collision amplitudes, and some aspects of the theory of the S matrix are indicated. (UK)

45494 STRONG-INTERACTION CHARACTERISTICS IN EXTENSIVE AIR SHOWER THEORY. Thielheim, K. O.; Beiersdorf, R. (Univ., Kiel). Z. Phys.; 236: 452-63(1970). (In German).

Results of three-dimensional Monte Carlo simulations of extensive air shower development are presented and compared with empirical data. The possibility of concluding various strong interaction parameters is discussed. (auth)

45495 PHENOMENOLOGICAL CURRENT ALGEBRA VERTEX. Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass. Rockefeller Univ., New York); Wise, Michael L. Contracts AT(30-1)-3178; AT(30-1)-3668 B. Ann. Phys. (N. Y.); 59: 129-64(Jul 1970).

A method is presented for constructing amplitudes which are the most general solutions to the Ward identities of current algebra. These solutions expressed in terms of undetermined scalar functions, exhibit a wide class of amplitudes which satisfy the current algebra constraints. Further information is obtained from the model dependent equal-time commutators of the space components of the currents by means of the Bjorken-Johnson-Low limits, which provide boundary conditions for certain asymptotic expansions of the scalar functions. Simple phenomenological models are discussed within this framework, and a connection between the Gilman-Harari model and hard pion models is established. (auth)

45496 RENORMALIZATION AND UNITARITY IN THE DUAL-RESONANCE MODEL. Gross, David J.; Neveu, A.; Scherk, J.; Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev., D; 2: 697-710(15 Aug 1970).

All the one-loop graphs of the dual-resonance model are explicitly calculated. These graphs fall into three categories: planar, nonorientable, and orientable nonplanar. Using the properties of various elliptic functions, the renormalization procedure, obtained previously for the planar diagrams, is generalized to the other two categories. The orientable nonplanar diagrams turn out to be particularly interesting. First, their integration regions have to be reduced from the ones naively obtained in order to avoid multiple counting. Secondly, they give rise to new singularities (branch points) in channels that are naturally identified as having vacuum quantum numbers. These singularities are probably related to the Pomeranchukon. The question of unitarity is explored at the one-loop level, i.e., to the first nontrivial order in the perturbation series. Although the counting of diagrams is somewhat subtle, a rather simple result emerges: All inequivalent diagrams (with respect to duality transformations) should be counted with equal weight. Finally, it is indicated that three of the four primitive renormalized loop operators of the theory can be obtained from the formulas of this paper. (auth)

45497 THEORY OF RELATIVISTIC SUPERMULTIPLETS. II. PERIODICITIES IN HADRON SPECTROSCOPY. Kursunoglu, Behram (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., D; 2: 717-35(15 Aug 1970).

The theory for all fundamental particles proposed earlier is further discussed and the higher hadron supermultiplets and the corresponding mass levels of the various spins and parities are calculated. Each supermultiplet is designated by the principal quantum numbers N_0 and N in the form $[N_0,N]$, where N_0 and N refer to the dimension numbers of the groups SO(3,2) and U(3,1), respectively. The generators of the groups SO(3,2) and U(3,1) constitute the algebraic basis of the fundamental wave equation. The results of the theory and the experimental data on hadron masses are found to be in excellent accord. The parities of the particles are obtained unambiguously, and the theory predicts 2^- and higher-spin mesons in addition to known ones. In the extreme limit of the parameters ρ and λ where $\rho = 0$, $\lambda = 0$, the [5,4], [5,6], [5,10], [5,15] levels each describe the photon, while the level [5,20] yields the graviton as a massless 2^+ particle. The limit $\rho = 0$, $\lambda = 0$ for the baryon and the lepton supermultiplets $[4_b,N]$, $[4_l,N]$, respectively, when coupled together implies the existence, at the lowest levels $[4_b,4]$ and $[4_l,4]$, of two $s = \frac{1}{2}$ two-component neutrinos. Higher-spin massive and massless leptons are also predicted. (auth)

45498 SPECTROSCOPIC SEARCHES FOR QUARKS. Skutnik, Bolesh J. (Radiation Processing, Inc., Westbury, N. Y.). Phys. Rev., D; 2: 635-41(15 Aug 1970).

Cosmological estimates indicate that quarks ought to be found in stellar sources, mainly, as bound to the nuclei of carbon, nitrogen, and oxygen. A method for predicting the electronic transitions for such species is presented and applied. The method of identifying lines in stellar spectra is discussed. Recently reported stellar ultraviolet spectra are inspected for possible coincidences. (auth)

45499 B MESON AND ITS CURRENT. Munczek, H. (Univ. of Kansas, Lawrence). Phys. Rev., D; 2: 653-7(15 Aug 1970).

The assumption that the B meson (1220 MeV, $J^{PC} = 1^{+-}$) and its chiral partner are gauge fields is examined. This leads to the introduction of an internal SU(6) group which contains SU(3) × SU(3) as a subgroup. The appropriate formalism and mass de-

generacy breaking are discussed by means of the use of non-linear realizations of the group. (auth)

45500 STRONG COUPLING IN STATIC MODELS. Goebel, Charles J. (Univ. of Wisconsin, Madison). pp 20-100 of Quanta. /Freund, P. G. O. (ed.). Chicago: University of Chicago Press (1970).

A comprehensive review is given of strong coupling in static models. The historical development of the theory of strong coupling is first treated. The classical calculation of meson scattering in the strong-coupling limit is then presented. A general treatment of Hamiltonian strong-coupling theory is outlined. The S-matrix (Chew–Low) method in strong coupling is then discussed. Solutions to the one-meson scattering problem are presented for the following cases: a) the isobars are nearly degenerate in mass; b) the harmonic oscillator or pair theory case; and c) the "stretched rotator" case. Appendices cover the following topics: coupling renormalization; dynamic binding from the S-matrix point of view; generalized static models; $O(g^{-2})$ corrections in Chew–Low theory; and "γ-excitations" in SU(2) × SU(2). (L.B.S.)

45501 PARITIES IN STRONG COUPLING MODELS. Dullemond, C. (Univ. of Nijmegen, Netherlands). pp 139-46 of Quanta. /Freund, P. G. O. (ed.). Chicago: University of Chicago Press (1970).

Several mechanisms to generate mixed parity spectra in static strong-coupling models and some of the difficulties which may be encountered are discussed. (L.B.S.)

45502 DIFFRACTION DISSOCIATION IN THE CHOU–YANG MODEL. Byers, N. (Univ. of California, Los Angeles); Frautschi, S. pp 367-95 of Quanta. /Freund, P. G. O. (ed.). Chicago: University of Chicago Press (1970).

Glauber's multiple scattering theory of nucleus-nucleus scattering is briefly summarized, and it is shown that if nucleon-nucleon scattering is mainly absorptive and spin and isospin independent, inelastic nuclear reactions occur which might be called diffraction dissociation. It is then shown that the Chou–Yang model may be regarded as a relativistic extension of Glauber's theory, and may also describe certain diffraction dissociation production reactions. Selection rules are given. Unfamiliar effects expected in hadronic diffractive productions are discussed. In particular, it is argued that forward dips which occur in the nuclear case need not occur in the hadronic case owing to the large mass changes. (L.B.S.)

45503 NATURE OF DIFFRACTION SCATTERING. Freund, Peter G. O. (Univ. of Chicago). pp 396-402 of Quanta. /Freund, P. G. O. (ed.). Chicago: University of Chicago Press (1970).

Some features of diffraction scattering that can be derived from rather general considerations are pointed out. In particular, a list of properties of the Pomeranchuk singularity is presented. (L.B.S.)

45504 OVERLAPPING RESONANCES. Bander, Myron; Coulter, Philip W.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev., D; 2: 944-5(1 Sep 1970).

The results obtained by Coulter and Shaw in describing dynamical effects in two overlapping resonances are generalized by showing that they are contained in the Wigner-Weisskopf treatment of decaying states. (auth)

45505 COMPLEX CONJUGATE POMERANCHUK TRAJECTORIES AND POMERANCHUK THEOREM FOR DIFFERENTIAL CROSS SECTIONS. Chylek, P. (Univ. of California, Riverside). Lett. Nuovo Cim.; 4: 381-4(29 Aug 1970).

An asymptotic ratio of the particle–particle and particle–antiparticle elastic differential cross sections for the case when the scattering is dominated by a pair of complex conjugate trajectories is investigated. (J.F.P.)

45506 REMARKS ON THE EQUIVALENCE BETWEEN NOETHER'S AND GEOMETRIC GENERATORS AND THE BROKEN ALGEBRA OF CONFORMAL INVARIANCE. Cheung, F. F. K.; Longo, S. A. (Univ. of Notre Dame, Ind.). Lett. Nuovo Cim.; 4: 436-40(5 Sep 1970).

The equivalence of Noether's definition and the geometrical one is demonstrated in Lagrangian models. It is concluded that the broken algebra involving only the Poincaré conformal generators and the divergence of the dilatation current is model independent. (J.F.P.)

45507 HYPOTHESIS OF SIMILARITY IN STRONG INTERACTIONS. I. PLURAL GENERATION OF e^+e^- ANNIHILATION HADRONS. Polyakov, A. M. (Landau Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 542-52(Aug 1970). (In Russian).

An hypothesis regarding asymptotic scaling invariance is proposed for studying the properties of strong interactions at small distances. A direct consequence of the hypothesis is the power asymptotic behavior of the amplitudes at very high momenta and at very large distances from the mass surface. It is shown that such asymptotic behavior agrees with the unitarity and analyticity conditions. Exact equations are formulated which describe the interaction of strongly virtual particles. Application of the equations to the $e^+e^- \rightarrow$ hadron high energy process yields the total cross section of the process and permits one to consider plurality of hadron generation and analyze the properties of the cross sections for generation of a prescribed number of hadrons under the condition that the number of hadrons is large. In conclusion, an analogy between the proposed theory and that for phase transitions of the second kind is considered and the role of SU(3) × SU(3) symmetry in the scheme is analyzed. (auth)

Strong (Baryon No. = 0)

45508 (IC–70/85) MESON SPECTRUM FROM THE VENEZIANO MODEL AND OTHER CONSEQUENCES. Lam, C. S. (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1970. 32p. Dep. CFSTI (U. S. Sales Only).

A general formula is deduced for trajectory intercepts for the Veneziano model starting from the requirement of simple, unique and complete factorizability in every multiperipheral configuration. The formula resembles but does not coincide with similar ones of previous authors, and the reason for the difference is analyzed. If one further requires that the degeneracy of each trajectory be minimized and that the Hagedorn temperature is 170 MeV if we take the slopes of the trajectories to be 0.9, then the formula forces some relations on the intercepts if the amplitude constructed is non-zero. This way either a mass relation is obtained or an extra selection rule over and above those usually adopted in strong interactions. If one takes the attitude of opting always for the mass formulas unless they are clearly violated, so as to guarantee a minimum number of extra selection rules, then one is forced to have, for example, (a) all positive G-parity (G) and positive normality (σ) nonstrange mesons to lie on the rho trajectory or its daughters, or else new selection rules arise; (b) all $G = -1$, $\sigma = -1$ non-strange mesons to lie on the pion trajectory or its daughters; (c) the pion trajectory lies below the rho trajectory; (d) within a meson nonet, the mass splitting is that of a quark model with ideal nonet mixing; (e) instead of having the spin-spin and spin-orbit couplings to split off various nonets, as in the usual quark model, we have the statement that the members of each nonet which consist of only "non-strange" quarks must lie on the ρ trajectory or its daughters if $\sigma = 1$, and on the π trajectory or its daughters if $\sigma = -1$; and (f) the extra selection rules are those of the ideal meson nonets. All the above predictions are quite well satisfied in nature, except that the pseudoscalar and axial vector octets do not have ideal nonet mixing. This is blamed on unitarity corrections. The problems of baryons and exotic mesons are also discussed. With the meson spectrum obtained above, the one-loop diagram is always divergent. The form of Gliozzi's gauge operator has to be slightly generalized for unequal intercepts, and a formula for that is given. (auth)

45509 (IC–70/91) BROKEN CHIRAL AND CONFORMAL SYMMETRY AND KUO TRANSFORMATION. Harun-Ar Rashid, A. M.; Rashid, M. A. (International Centre for Theoretical Physics, Trieste (Italy)). Aug 1970. 17p. Dep. CFSTI (U. S. Sales Only).

The breaking of conformal and chiral symmetry within the framework of effective Lagrangians is studied and it is shown that the (8,8) type of symmetry-breaking leads to unacceptable values of the pion-pion scattering lengths. A combination of $(3,\bar{3}) + (\bar{3},3)$ and (8,8) is then proposed, the particular form being uniquely fixed by the requirement of Kuo transformation. This is then shown to lead to improved scattering lengths for meson-meson scattering processes. (auth)

45510 SOME APPLICATIONS OF A SIMPLE APPROACH TO UNITARIZATION IN HARD-MESON CALCULATIONS. Rockmore, Ronald (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 2: 593-7(1 Aug 1970).

Several applications of a simple approach to unitarization in the case of the three-point functions of hard-meson theory are made. For the first of these, effective-range formulas are obtained for the pion form factor in the timelike region for both hard-pion current-algebra ($\delta = -\frac{1}{2}$) and Veneziano models. Next, the extension of this procedure to the case of several coupled channels is used to obtain an effective-range formula for the pion form factor which includes the small effect of the closed $K\bar{K}$ channel. Finally, an expression for the pion form factor is derived which allows for the inclusion of some nonresonant p-wave (I = 1) $\pi\pi$ scattering. Since this component is parame-

trized via the introduction of an additional (nonresonant) p-wave scattering length, the resulting expression for the pion form factor generates a one-parameter family of fits to the experimental data. The data appear to be consistent with a small positive nonresonant scattering length and favor a value of Γ_ρ slightly less than 124 MeV. (auth)

45511 ABSORPTION MODEL APPLIED TO $\pi-\pi$ SCATTERING. Chan, L.; Hagopian, V. (Univ. of Pennsylvania, Philadelphia. Florida State Univ., Tallahassee). Phys. Rev., D; 2: 583-9(1 Aug 1970).

A study of the possibility of using an absorption model to obtain a unique s-wave I = 0 $\pi\pi$ phase shift from the reaction $\pi^-p \to \pi^-\pi^+n$ was made. Applying the model to combined data from several laboratories, a set of reasonable (but twofold ambiguous) values for the isospin-zero s-wave phase shift δ_0^0 was obtained, using the isotropic moment of the dipion decay distribution. Values for δ_0^0 deduced by using the s-p wave interference term in the dipion decay cross section agreed well with previous (twofold ambiguous) results obtained by extrapolation procedures. Comparing the two sets of twofold ambiguous solutions for δ_0^0, the lower or "down" branch was preferred marginally in the dipion mass region below the ρ meson. No unique conclusion could be drawn in the higher-mass region. The model dependence of these results is emphasized, but it is believed that similar studies with improved statistics for $-t > \mu^2$ would yield similar results. Good data for $-t < \mu^2$ are required to do definitive model-independent analyses. (auth)

45512 SUMMING SOFT PIONS. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 2: 674-84(15 Aug 1970).

Matrix elements are calculated for high-energy reactions in which an unlimited number of soft pions are emitted or exchanged. (auth)

45513 VENEZIANO AMPLITUDES FOR $\pi\pi$, πK, AND KK SCATTERING AND CHIRAL SYMMETRY BREAKING. McKay, Douglas W.; Palmer, William F.; Wada, Walter W. (Ohio State Univ., Columbus). Phys. Rev., D; 2: 742-52(15 Aug 1970).

$\pi\pi$, πK, and KK single- and multiple-term Veneziano amplitudes are studied as a coupled system. Adler and Adler–Weisberger conditions are imposed, and it is found that the single-term system cannot satisfy all of the PCAC (partial conservation of axial-vector current) and charge-algebra constraints. The multiple-term system, constructed to satisfy these constraints, results in much improved width predictions. These improved amplitudes are used to study chiral symmetry breaking by investigating the Σ terms. It is found that a single $(3,3^*) \oplus (3^*,3)$ representation is not sufficient to explain the symmetry breaking, whereas a mixture of $(3,3^*) \oplus (3^*,3)$ and $(1,8) \oplus (8,1)$ is sufficient (but not necessary). The admixture of $(1,8) \oplus (8,1)$ is considerable. (auth)

45514 DISPERSION RELATIONS AND ASYMPTOTIC BEHAVIOR OF THE VENEZIANO PARTIAL-WAVE AMPLITUDE IN THE COMPLEX s PLANE. Park, Robert T.; Desai, Bipin R. (Univ. of California, Riverside). Contract AT(11-1)-34 P107A. Phys. Rev., D; 2: 786-92(15 Aug 1970).

The asymptotic behavior of the Veneziano partial-wave I = 1 amplitude $V_l(s)$ for $\pi\pi$ scattering is studied in the complex s plane for physical l values. The ρ-f^0 exchange-degenerate trajectory is of the form $\alpha(s) = as + b$. For $b < 1$ and $3b + 4am_\pi^2 \geq 1$, it is shown that, asymptotically, $V_l(s) \sim o(s^{b-1})$. Under the same conditions, the resonance partial widths for fixed l have the property $\Gamma s_R \sim o(s_R^{-b})$. The discontinuity of $V_l(s)$ across the left-hand cut oscillates, and if $b < 1$, then, asymptotically, disc $V_l(s) \sim o(s^{-2b-4am_\pi^2})$. In the case $-2am_\pi^2 < b < 1$, disc $V_l(s) \to 0$ as $s \to -\infty$ and $V_l(s) \to 0$ as $|s| \to \infty$ and $V_l(s)$ can be written in the form of unsubtracted partial-wave dispersion relations, i.e., as an integral along the left-hand cut plus the sum of an infinite number of poles along the right-hand real axis. Thus for the particular case of the ρ-trajectory ($b \approx 1/2$, $a \approx 1$ BeV^{-2}), an unsubtracted dispersion relation can be written. (auth)

45515 ASYMPTOTIC BEHAVIOR OF PARTIAL WIDTHS IN THE VENEZIANO MODEL OF SCATTERING AMPLITUDES. Nambu, Yoichiro; Frampton, Paul (Univ. of Chicago). pp 403-14 of Quanta. /Freund, P. G. O. (ed.). Chicago: University of Chicago Press (1970).

A general procedure is given for determining the partial wave residues of the Veneziano amplitudes at sufficiently high resonance energies. This is explicitly worked out for π-π scattering, and it is found that the residues are all asymptotically positive if the Regge intercept $\alpha(0) > 1/3$. (auth)

45516 DOUBLE-SCATTERING MODELS AND CHEW–LOW EXTRAPOLATIONS. Kimel, J. D. (Florida State Univ., Tallahassee). Phys. Rev., D; 2: 862-9(1 Sep 1970).

A formalism is presented by which absorptive corrections to single-particle and Regge-pole exchange amplitudes in quasi-two-body inelastic processes can be expressed as a highly convergent power series in t. This representation does not require a partial-wave decomposition of the scattering amplitudes and can be written down by inspection in terms of the single-particle or Regge-pole helicity amplitudes. The method is used to calculate the effects of absorption in the determination, through Chew-Low extrapolation techniques, of $\pi\pi$ phase shifts when the dipion effective mass is in the ρ region. These calculations show quantitatively the importance of absorption in the choice of extrapolation procedures. (auth)

45517 POSSIBLE CONTRIBUTION OF REGGE CUT TO HIGH-ENERGY CROSS SECTIONS OF pp, $\bar{p}$p, K^+p, AND K^-p REACTIONS. Warty, M. D. (Victoria Jubilee Technical Inst., Bombay). Phys. Rev., D; 2: 936-41(1 Sep 1970).

The elastic scattering cross-section data on K^+p and pp reactions are discussed, and the possibility of explaining the data by considering the contribution of the Pomeranchukon pole is investigated. It is then considered whether the contribution due to a cut in the complex angular momentum plane instead of that due to the Pomeranchukon can explain the sum of the total cross sections of the pp and $\bar{p}$p reactions, and that of the K^+p and K^-p reactions. The calculated values have been compared with the older data along with the recently available Serpukhov machine data up to 55 BeV/c. It is concluded that both sets of reactions may be largely explained by a cut. Finally, by considering the differences between the particle-particle and particle-antiparticle cross sections, it is predicted that at high energies, the pp and K^+p reactions should show a small decrease in their total cross sections. (auth)

45518 CONCERNING THE PROBLEM OF THE A_2 MESON. Khalfin, L. A. (Steklov Mathematics Inst., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 11: 308-10(5 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 454-6(5 May 1970).

It is suggested that a careful study of $d\sigma(\pi^-p \to \eta n)/dt$ as a function of s and t in as large an interval of t as possible at the maximum s will provide the answer to the question of how many A_2 mesons exist and what are their quantum numbers. In addition, such reactions as K^+N scattering and the charge exchanges $K^-p \to \bar{K}^0n$ and $K^+n \to K^0p$ are necessary for an independent estimate of the contributions of singularities such as cuts. (L.B.S.)

45519 SOME INVESTIGATIONS ON THE VENEZIANO MODEL. Bartl, A. (Univ., Tuebingen, Ger.); Urban, P. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II; 178: 199-215(1969). (In German).

The extension of Veneziano models for mesons with arbitrary spin is investigated. Mass formulas are obtained in good agreement with experiment. (tr-auth)

45520 FROISSART BOUNDS WITH NO ARBITRARY CONSTANTS. Common, A. K. (CERN, Geneva). Nuovo Cim.; 69A: 115-32(1 Sep 1970).

A method is described for calculating rigorous upper bounds to averaged total cross sections $\overline{\sigma_{tot}(s)}$ for $\pi\pi$ scattering defined by $\overline{\sigma_{tot}(s)} = ((m+1)/(s-4\mu^2)^{m+1}) \int_{4\mu^2}^{s} (s'-4\mu^2)^m \sigma_{tot}(s')\, ds'$ for all energies and all $m \geq 1$, from the D-wave scattering length α_2^2 in the t-channel or alternatively from a rigorous bound for the D-wave amplitude $\alpha_2(t_0)$ at one value of t_0 between 0 and $4\mu^2$. It is shown that as $s \to \infty$, the bound to $\overline{\sigma_{tot}(s)}$ is equivalent to the Froissart bound $\overline{\sigma_{tot}(s)} \lesssim (4\pi(m+1)/t_0 m)\,[\log(s/s_0)]^2$, where the scaling factor s_0 can be calculated from the given information and $t_0 = 4\mu^2$ when the scattering length is used. By letting $m \to \infty$ the usual bound is obtained. Similar results are derived for the fixed-angle, fixed-t and forward $\pi\pi$ scattering amplitudes, and again the bounds are asymptotically equivalent to the corresponding Froissart bounds and contain no unknown constants. (auth)

45521 THE $\pi\pi\pi N\bar{N}$-FIVE-POINT FUNCTION. Dosch, H. G.; Mueller, V. F. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys.; 236: 192-212(1970).

Choosing a suitable covariant decomposition of the $\pi\pi\pi N\bar{N}$-five-point function the crossing relations are derived and a complete reduction of them is given. The implications of the known factorization properties at the one-particle singularities of the invariant functions on their assumed Regge behavior are investigated and a set of asymptotic relations between them is found. A mass degenerate parity doublet of the nucleon can remove the relations connected with the nucleon poles. (auth)

45522 DUALITY AND CROSSING SYMMETRY OF THE NARROW RESONANCE MODEL. Nakazawa, K. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Phys.; 48: 1426-9(15 Jun 1970).

In the narrow resonance approximation, conditions of duality

and crossing symmetry are derived using the finite energy sum rule for an amplitude which is completely determined as a function of two complex variables by its meromorphic part in one of these variables. As an example, the one term Veneziano amplitude is discussed. (auth)

45523 NEW MODEL FOR THE s-WAVE ($\eta^0 \to 3\pi$) AND ($X^0 \to 3\pi$) AMPLITUDES AND THE $\Gamma(X^0 \to \eta\pi\pi)$, THE $\Gamma(X^0 \to 3\pi)$ AND $\Gamma(X^0)$ TOTAL DECAY WIDTHS. Oppo, G. (Polytechnic Inst., Brooklyn). Lett. Nuovo Cim.; 4: 441-2(5 Sep 1970).

A model is presented for the $\eta^0 \to 3\pi$ amplitude. This approach is also used for the $X^0 \to 3\pi$ vertex and to obtain estimates of the width of $X^0 \to \eta^0\pi\pi$ and the total width of X^0. (J.F.P.)

45524 EVALUATION OF THE PION ELECTROMAGNETIC FORM FACTOR. Ghika, G.; Visinescu, M.; Cristu, M. I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 413-8 (1970).

The purpose of this study is to connect the pion electromagnetic form factor to the Veneziano amplitude for the $\pi\pi$ scattering by imposing elastic unitarity. The corresponding Omnès equation for the pion form factor is solved, and the results are compared with the experimental data. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 45422, 45427, 45436, 45517, and 45570.

45525 PION–NUCLEON SCATTERING FROM 50 TO 500 GeV/c. Dean, N. W. (Vanderbilt Univ., Nashville). Phys. Rev., D; 2: 621-3(1 Aug 1970).

The general features to be expected in scattering at energies high enough that the scattering amplitude consists of only the Pomeranchuk Regge pole and the two-Pomeranchuk-cut terms are shown. The predictions of the Reggeized multiple-scattering quark model for pion-nucleon scattering at lab momenta up to 500 GeV/c are given as a specific example. (auth)

45526 UNITARITY UPPER BOUNDS AND ELASTIC SCATTERING. Ravenhall, D. G.; Pardee, W. J. (Univ. of Illinois, Urbana). Phys. Rev., D; 2: 589-92(1 Aug 1970).

A derivation is given in terms of the eikonal formalism of a recently derived upper bound on the absorptive part of a spin-zero elastic scattering amplitude. The multivaluedness inherent in the problem is explored, and considerably smaller upper bounds are obtained by imposing conditions of reasonability on the profile function. Experimental differential cross sections for $\pi^\pm$p and pp elastic scattering over a wide energy range are found to fall on a universal curve, which lies just below our most stringent upper bound over a range of three decades in $d\sigma/dt$. (auth)

45527 REGGE CUTS AND THE VENEZIANO MODEL IN BACKWARD πN SCATTERING. Amann, R. F. (Univ. of Chicago). Phys. Rev., D; 2: 561-8(1 Aug 1970).

The Reggeized absorptive cut is included in three Regge-pole (the Δ, N_α, N_γ) fits to backward $\pi N \to N\pi$ differential cross sections. The over-all framework of the Veneziano model is used, and successful fits are found with smooth one-parameter residues. The cuts remove the Veneziano model's contradictions with experiment, are essentially parameterless, and are definitely non-negligible. Methods to verify their presence are discussed. The usual difficulty in extrapolating to the Δ mass (too small a width) remains unresolved. Possible explanations of this problem are discussed. (auth)

45528 RHO MESON AND PION–NUCLEON SCATTERING. Urani, John Roy. Columbia, Mo.; Univ. of Missouri (1969). 101p.

Thesis.

The LSZ reduction of the S-matrix for quantum field theory in the Heisenberg picture is used to evaluate the contribution of the ρ meson to the calculation of low energy pion–nucleon partial wave scattering parameters. Two models are employed in this investigation. A ρ-exchange model is used along with the assumption of ρ-dominance of the isovector form factors to calculate the s and p-wave scattering lengths and s-wave effective ranges. Excellent agreement with experiment is found using this model. A current algebra model is constructed and it is shown that the ρ meson does not contribute to the scattering in the limit of massless pions. An equality is found which verifies the ρ-dominance assumption for the nucleon. Rho exchange and current algebra models are constructed for pion–pion scattering. Another relation is found which verifies the ρ-dominance assumption for pions. Possible corrections to the ρ-dominance assumption for both pions and nucleons are discussed. (Diss. Abstr. Int., B)

45529 POSSIBLE EXISTENCE OF A NEW NUCLEON STATE. Azimov, Ya. I. (Ioffe Physical-Technical Inst., Leningrad). Phys. Lett.; 32B: 499-500(17 Aug 1970).

Nucleon state in one unitary multiplet with $\Sigma(1475)$ is discussed. It seems to be possible that its mass is below the πN threshold. (auth)

45530 INDUCTION OF QUARKLIKE STRUCTURE OF BARYONS. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 2: 780-5(15 Aug 1970).

A set of self-consistency conditions for the interactions of a hypothetical set of even- and odd-parity mesons and baryons is studied. These conditions, previously derived, are written in a form that makes some of their implications transparent. Two types of SU(n)-invariant solutions are found; in only one of these do baryon exchanges participate in the bootstrapping of the baryons. The conditions imply that the meson–baryon–baryon interactions are proportional to matrix elements of the group generators in the space of a single quark, yet the identification of baryons with simple quarks does not lead to a solution. Thus, the baryons may be regarded as composites containing quarks. An approximate solution based on the SU(6) group may correspond to experiment better than any exact solution. (auth)

45531 CHARGED SCALAR MESOTRON FIELD. Schwinger, J. (Harvard Univ., Cambridge, Mass.). pp 101-38 of Quanta. /Freund, P. G. O. (ed.). Chicago: University of Chicago Press (1970).

A review is given of the theory of the charged scalar mesotron field. Beginning with the general theory, the model considered is that of a Pauli–Weisskopf scalar field interacting with an infinitely massive nuclear particle through a finite-distance coupling. Mesotron scattering is then treated in detail. The results are then obtained by a purely classical calculation. A quantum mechanical treatment of the charged scalar field is outlined that bears more resemblance to the classical development than the method of expansion in orthogonal functions. (L.B.S.)

45532 MULTI-REGGE-MODEL ANALYSIS OF $\pi^-p \to \pi^+\pi^-\pi^-p$ AT 5 GeV/c. Jones, S. T. (Univ. of Illinois, Urbana). Phys. Rev., D; 2: 856-62(1 Sep 1970).

A multi-Regge model is fitted to portions of the 5-GeV/c Illinois data for $\pi^-p \to \pi^+\pi^-\pi^-p$. Mass distributions are fitted. Momentum-transfer distributions are fitted in general, but quantitative predictions of the mass dependence of the diffractive peak are systematically high. The over-all fit is good. (auth)

45533 DUALITY AND THE NON-POMERANCHUK CONTRIBUTIONS TO πN AND $\bar{K}$N CROSS SECTIONS. Capps, R. H.; Dixit, V. V. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 2: 946-7(1 Sep 1970).

The recent results of Trilling, concerning the non-Pomeranchuk contributions to meson-baryon cross sections, are shown to be consistent with SU(3) symmetry and a simple duality assumption. (auth)

45534 KINEMATIC SCALING IN HIGH-ENERGY HADRON–HADRON COLLISIONS. James, P. B. (Univ. of Missouri, St. Louis). Phys. Rev., D; 2: 948(1 Sep 1970).

A possible explanation for qualitative differences between meson-nucleon and nucleon-nucleon total cross sections at Serpukhov energies is discussed. The argument is based on a composite structure (quark) model for the hadrons. (auth)

45535 ALGEBRA OF PION SOURCES. Pradhan, T. (International Centre for Theoretical Physics, Trieste, Italy. Saha Inst. of Nuclear Physics, Calcutta); Khare, A. V. Phys. Rev., D; 2: 941-3(1 Sep 1970).

Assuming that the space integrals of source terms (sources) in the Klein–Gordon equation for the pion fields together with isospin generators form an SU(2) $\otimes$ SU(2) algebra which, in the soft-pion limit, is a good symmetry of the strong interactions, S-wave scattering lengths for the collision of pions with hadron targets as well as the pion-nucleon coupling constant are calculated. The results are in excellent agreement with experiment. (auth)

45536 π-B EXCHANGE-DEGENERATE MODEL FOR $V^0\Delta^{++}$ PRODUCTION. Abrams, G. S.; Maor, U. (Univ. of California, Berkeley). Phys. Rev. Lett.; 25: 621-5(31 Aug 1970).

The forward differential cross section of $\rho\Delta$ production is shown to be reproduced quantitatively by an evasive Reggeized one-pion-exchange model which smoothly reduces to the Born term at the pion pole. Assuming exact π-B exchange degeneracy leads to predictions for $\omega\Delta$ production which are in agreement with the experimental s and t dependences. Similar agreement is found for $K^*\Delta$ production. (auth)

45537 PRODUCTION OF $\pi\pi$ RESONANCES IN A DUAL MODEL FOR THE $\pi\pi\pi N\bar{N}$ FIVE-POINT FUNCTION. Bender, I. (Univ., Heidelberg); Dosch, H. G.; Mueller, V. F.; Rothe, H. J. Lett. Nuovo Cim.; 4: 385-90(29 Aug 1970).

The predictions of the dual-resonance model for the $\pi\pi\pi N\bar{N}$ five-point function are presented for the differential cross sections and decay angular distributions of $\pi\pi$ resonances produced at high energies. The interactions $\pi + N \rightarrow \bar{\pi} + \bar{\pi} + N$ at high pion energy, small four-momentum transferred between the nucleons and with the invariant mass of the produced pions in the ρ and f resonance region are discussed. (J.F.P.)

45538 DUAL RESONANCE MODEL FOR THE $\pi\pi\pi N\bar{N}$ FIVE-POINT FUNCTION. Bender, I. (Univ., Heidelberg); Dosch, H. G.; Mueller, V. F.; Rothe, Heinz J. Z. Phys.; 237: 107-20(1970).

Assuming that the Bardakçi-Ruegg B_5-function is relevant for the dynamical description of hadronic single particle production process a model for the $\pi\pi\pi N\bar{N}$-five-point function is constructed. For the invariant functions appearing in a suitably chosen invariant decomposition an ansatz is made in terms of B_5-functions multiplied by polynomials of the invariant variables which are required by factorization. The Regge trajectories introduced are those of the π, ρ, P', ω and N. With this set of trajectories, admitting as small a number of satellite terms as possible, invariant functions are constructed having both the correct crossing and factorization properties at the π, N (and $\bar{N}$) poles. Further constraints emerge from an investigation of the asymptotic behavior in the single Regge limits. Only one parameter remains undetermined. As an application of the model consequences for the process $\pi N \rightarrow \rho N$ are studied. (auth)

45539 NEGATIVE P'-POLE PARAMETERS AND VANISHING TOTAL CROSS SECTIONS IN HIGH-ENERGY piN SCATTERING. Giesecke, J. (Institut fuer Hochenergiephysik, Heidelberg). Z. Phys.; 237: 335-44(1970).

In πN forward scattering the conventional P'-pole can be simulated by two vacuum poles with $\alpha(0) < 0$ and different signs of the residues. In the regions $-0.3 \leqq \alpha_{P'}(0) \leqq -0.1$ and $-0.8 \leqq \alpha_{P''}(0) \leqq -0.4$ the practically identical fits to the πN scattering data from 8 to 65 GeV/c yield $0.98 \leqq \alpha_P(0) < 1$. The dispersion theoretical sum rule for the scattering length $a^{(+)}$ is fulfilled because of the negative P' residue; it is used as a finite-energy sum rule with N = 8 GeV/c. (auth)

45540 DIFFICULTIES WITH THE RENORMALIZED σ-MODEL IN THE LIMIT OF INFINITE σ-MASS. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy); Remiddi, E. Lett. Nuovo Cim.; 4: 466-72(5 Sep 1970).

The $m_\sigma \rightarrow \infty$ limit of the renormalized NNπ vertex amplitude is studied within the linear σ model. The result is negative. The renormalized NNπ vertex is found to show a logarithmic behavior in m_σ as $m_\sigma \rightarrow \infty$. The problem of renormalizing nonlinear σ models seems to be of even harder solution if not at all impossible. (J.F.P.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 45517, 45627, and 45728.

45541 (INP-697) HIGH-ENERGY SCATTERING FROM NUCLEI. Czyz, Wieslaw (Institute of Nuclear Physics, Krakow (Poland)). 1970. 124p. Dep. CFSTI (U. S. Sales Only).

The applicability to various collision processes of the diffractive multiple scattering model (Glauber model) is discussed with a special emphasis on nuclear high energy collisions. (auth)

45542 (NYO-2262-TA-223) AN EIKONAL MODEL FOR LARGE-ANGLE np AND pp ELASTIC SCATTERING. Fried, H. M.; Raman, K. (Brown Univ., Providence, R. I. Dept. of Physics). Jul 1970. 10p. Dep. CFSTI.

An eikonal model is described for large-angle np and pp elastic scattering at medium energies. Each amplitude is parametrized as a sum of one-boson-exchanges modulated by the multiple virtual emission of soft neutral I = 0 and I = 1 vector mesons. Fits to the data are presented. (auth)

45543 VERY-HIGH-ENERGY LIMIT OF PROTON–PROTON SCATTERING. Barut, A. O.; Plywaski, W. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 2: 572-7(1 Aug 1970).

A contact interaction between the protons was evaluated using the vector currents and wave functions provided by the relativistic O(4,2) model. The resulting enveloping differential cross section at $s = \infty$ is discussed and compared with experiment over the entire range of accessible momentum-transfer values. (auth)

45544 SOME ASPECTS OF REGGE POLE CONSPIRACY IN NUCLEON–NUCLEON SCATTERING. Pal, Bimal Kumar. Riverside, Calif.; Univ. of California (1969). 49p.

Thesis.

In order to reconcile theory with experiment for high-energy np charge exchange scattering, various conspiracy models are discussed. The proximity of the pion pole in the forward direction is expected to play a dominating part in explaining the sharp peak persisting to very low energies in the differential cross-section with constant width of about 0.01 Gev^2. In a simple Regge pole model, the pion residue vanishes at t = 0. The idea of conspiracy has given rise to a type of mechanism through which the pion contribution instead of vanishing at t = 0, can cause a sharp peak in the differential cross section provided one assumes the existence of a $P = (\text{even})^+$ trajectory, the other member of an M = 1 parity doublet. Two assumptions are made about residue functions so that the peak can be made to resemble the data. Another mechanism is considered for which the usual pion residue vanishes at t = 0. This is M = 0 pole for the pion quantum numbers. In addition, there exists an M = 1 parity doublet with nonvanishing residues at t = 0, one of which interferes with the pion to give rise to the sharp peak in the np charge exchange cross section. The fits to the experimental np charge exchange data are very good in the forward direction. (Diss. Abstr. Int., B)

45545 PREDICTIONS AND TESTS OF THE HYPOTHESIS OF LIMITING FRAGMENTATION. Vander Velde, J. C. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 32B: 501-4(17 Aug 1970).

It is shown that the hypothesis of limiting fragmentation predicts the way in which the cross sections for production of fast particles in the laboratory should scale with beam energy. The agreement with experiment is investigated for the production of protons and pions in p–p and p–aluminum collisions in the beam momentum range 12 to 70 GeV/c. (auth)

45546 ELASTIC SCATTERING OF HIGH-ENERGY PARTICLES ON NUCLEI. Barashenkov, V. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Usp. Fiz. Nauk; 100: 425-48(Mar 1970). (In Russian).

Until recently a semiphenomenological optical model served as the basis for calculating the scattering of fast particles on nuclei; this method makes it possible to derive the scattering cross section by a simple summing operation. However, this model does not take into account certain important physical aspects of the problem; therefore calculations were made concerning the passage of particles through media which consist of scattering and absorbing centers (nucleons). The examination includes a review of multiple diffraction scattering, nucleon–deuteron scattering, scattering of nucleons on helium, carbon, and oxygen nuclei and the transition to the optical approximation. The diffraction picture, derived from the theory of R. J. Glauber, involving the interference of amplitudes caused by a varying number of intranuclear collisions, is examined more closely. (Review article, 41 ref.) (TTT)

45547 FUNDAMENTAL NUCLEAR INTERACTION. Green, Alex E. S. (Univ. of Florida, Gainesville). Science; 169: 933-41(4 Sep 1970).

The effects of mesons in the theory of nuclear forces are reviewed. The parallel features of the electromagnetic interactions, nuclear interactions and phase shifts, mesons and the N + N interaction, and scalar mesons and quarks are discussed. (J.F.P.)

45548 INELASTIC pp SCATTERING. Goldberg, Hyman (Northeastern Univ., Boston). Phys. Rev., D; 2: 839-42(1 Sep 1970).

Inelastic pp scattering processes are studied with a view to testing certain models of diffractive processes. In resonance production, exchange of a Pomeranchon is shown to lead to Treiman–Yang isotropy at $t \approx -2\ (\text{GeV/c})^2$. The implications of factorization are then presented. Finally, the predictions of a form-factor model (like that of Abarbanel, Drell, and Gilman for elastic pp scattering) for pp scattering to the continuum are compared with experiment. (auth)

45549 DISSOCIATION AN STRIPPING OF HIGH-ENERGY DEUTERONS. Faeldt, Goeran (Harvard Univ., Cambridge, Mass.). Contracts AF 49(638)-1380; AT(30-1)-2076. Phys. Rev., D; 2: 846-55(1 Sep 1970).

The dissociation and stripping of high-energy deuterons are studied in a Glauber-model approach. In particular, the treatment of the dissociation problem includes both nuclear and Coulomb forces. For heavy nuclei, the Coulomb dissociation cross section turns out to be much more important than the nuclear dissociation cross section and comparable in magnitude to the nuclear-stripping cross section. Comparison with experi-

mental cross sections for 3.54-GeV/c deuterons shows satisfactory agreement. (auth)

45550 VENEZIANO MODEL FOR NUCLEON–NUCLEON SCATTERING. Paige, Frank E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 2: 922-35(1 Sep 1970).

A Veneziano model is constructed for nucleon-nucleon scattering. Each parent trajectory in the model has no parity or isospin doublets, and its residues satisfy the factorization theorem and positivity conditions. (auth)

45551 CRITIQUE ON "UNIVERSAL THEORY OF PRIMARY INTERACTIONS AND NUCLEON-NUCLEON SCATTERING." Bryan, Ronald (Texas A and M Univ., College Station). Phys. Rev., D; 2: 902-10(1 Sep 1970).

Remarks are made on a calculation of low-energy nucleon-nucleon scattering carried out by Chiang, Gleiser, Huq, and Saxena, who use Sudarshan's "universal vector and axial-vector interaction theory" in a one-boson-exchange potential approximation. It is shown that the test of high-mass meson exchange forces comes in fitting the lower partial waves ($l \leq 2$), not in fitting the higher partial waves ($l \geq 3$), since mere one-pion exchange accounts for most of the observed scattering in the higher partial waves. Thus Chiang et al.'s admittedly poor fit to some of the lower partial waves would seen to disprove Sudarshan's model. However, an error in the treatment of the one-ρ-exchange potential is pointed out, the correction of which will significantly improve the fit to the data, although the over-all agreement will still be poor. It is also pointed out that Sudarshan's assumption, that the ω-nucleon coupling constant equals the ρ-nucleon coupling constant, is both arbitrary and in conflict with experiment, and that if g_ω^2 is altered to agree with experiment, the model will be in considerably better agreement with experiment. Finally, it is noted that the model also lacks sufficient intermediate-range attraction, but that this is due in part to the neglect of the two-pion-exchange terms in Chiang et al.'s calculation. With the inclusion of 2π effects, the Sudarshan model should correctly predict the qualitative features of low-energy nucleon-nucleon scattering. However, a precise fit will likely require the exchange of the $\epsilon(715, T = 0, J = 0^+)$, and Sudarshan's model makes no provision for such a meson. (auth)

45552 HIGH-ENERGY HADRON–HADRON SCATTERING IN OPTICAL-MODEL AND S-MATRIX DESCRIPTIONS. Islam, M. M. (Univ. of Connecticut, Storrs). Lett. Nuovo Cim.; 4: 447-53(5 Sep 1970).

High-energy proton–proton elastic scattering as described by the optical model and the S-matrix is discussed. One model is considered in which it is seen how the same basic process is described differently in the two descriptions, wherein lies the superiority of the one over the other, and how they fit in together. (J.F.P.)

45553 EXCHANGE INTERACTION OF AN ISOBAR WITH A NUCLEON AND DYNAMIC MODEL OF TWO-BARYON RESONANCE. Karmanov, V. A.; Kondratyuk, L. A.; Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 374-6(5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 543-7 (5 Jun 1970).

Multibaryon resonances, that is, nuclei in which one of the nucleons is replaced by a baryon resonance, are considered. The exchange forces due to the existence of the decay interaction $\Delta \rightarrow \pi + N$ are investigated starting with the Lippmann–Schwinger integral equation. (J.F.P.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 45449, 45574, and 45575.

45554 (IFVE-STF-69-91) REPRESENTATIONS OF THE GROUP OF COMPLEX MATRICES L(n,C). Leznov, A. N.; Savel'ev, M. V.; Fedoseev, N. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An explicit form of the matrix elements of arbitrary transformations and the characters of irreducible representations of group L(n,C) were obtained, using transition to the "limit" representation. The application of the method, based on the explicit definition of bilinear invariant positive definite Hermitian form, allows one to describe all the series of unitary representations. The connection of the method of limit representation and method, based on the induced representations is clarified. (auth)

45555 (NYO–3829-52) UNITARY IRREDUCIBLE REPRESENTATIONS OF SU(2,2), REDUCTION WITH RESPECT TO AN ISO-POINCARE SUBGROUP. Yao, Tsu (Pittsburgh Univ., Pa. Dept. of Physics). Jun 1970. Contract AT(30-1)-3829. 94p. Dep. CFSTI.

The unitary irreducible representations of SU(2,2), the covering group of the conformal group, are reduced with respect to an iso-Poincaré subgroup, E(3,1). Explicit representations of the 15 generators of SU(2,2) in terms of differential operators in the function space of $|\eta, \xi, \epsilon; s, t, m>$, $|\omega, \xi, \epsilon; r, t, m>$, and $|\xi, \epsilon; t, m>$, the basis vectors for "time-like," "space-like," and "light-like" UIR's of E(3,1) respectively, are given. The matrix elements between a basis vector in the maximal compact subgroup SU(2) × SU(2) × U(1) and a basis vector in E(3,1) are calculated for all 14 different classes of UIR's of SU(2,2). It is found that two classes are reducible with respect to "light-like" representations, four classes are reducible with respect to "time-like" representations, and eight classes are reducible with respect to "space-like" representations of E(3,1). (auth)

45556 GEOMETRY OF BROKEN SYMMETRIES. Yodzis, P. (New Mexico State Univ., Las Cruces). Nuovo Cim.; 68B: 153-64(11 Aug 1970).

A consideration of the fundamental requirements of relativistic invariance for the global observables of relativistic quantum systems leads to the postulate that these observables should be treated as geometric objects on the manifold of spacelike hyperplanes in Minkowski space. The problem of determining the most general possible (in the sense of being consistent with the demands of relativistic covariance) coupling of the Poincaré Lie algebra of an "internal" symmetry is then dealt with in terms of connections (in the sense of differential geometry) on fields of Lie algebras over the manifold of hyperplanes. It is found that the possible couplings are considerably more restricted than one might have expected. (auth)

45557 BROKEN CHIRAL AND CONFORMAL SYMMETRY IN AN EFFECTIVE-LAGRANGIAN FORMALISM. Isham, C. J.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 2: 685-90(15 Aug 1970).

The simultaneous breaking of conformal and chiral symmetry is investigated within the framework of nonlinear realizations and effective Lagrangians. The explicit introduction of a massless dilaton field, χ enables conformal invariance to be preserved in Lagrangians for massive matter fields. It is shown that the equation of Callan, Coleman, and Jackiw, $\partial_\mu D_\mu = \theta_{\mu\mu}$, remains valid notwithstanding the introduction of this particle, and also that it is possible to construct Lagrangians which are simultaneously invariant under the chiral and conformal groups. If a term which explicitly violates both symmetries is introduced, then the dilaton acquires a definite (bare) mass which can be expressed in terms of the masses of the chiral bosons—the pion in the case of chiral SU(2) × SU(2), the pion and kaon in the case of chiral SU(3) × SU(3). The precise form of this mass relation depends upon the type of symmetry-breaking term adopted. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 45479.

45558 REMARKS ON VECTOR POLARIZATION IN ELASTIC ELECTRON–DEUTERON SCATTERING. Prepost, R. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., D; 2: 624(1 Aug 1970).

Some remarks are made about the recoil deuteron vector polarization in elastic electron–deuteron scattering and the relation of time-reversal invariance. (auth)

45559 WHAT IS NOT INVARIANT UNDER TIME REVERSAL? Kabir, P. K. (Rutherford High-Energy Lab., Chilton, Eng.). Phys. Rev., D; 2: 540-2(1 Aug 1970).

The departure from T invariance in neutral K-meson decays is shown to be directly demonstrable through suitable measurements. The predicted asymmetries include a CP- and T-non-invariant effect larger than any which has been measured so far. (auth)

45560 LOW-ENERGY THEOREMS ON K_{l3} DECAY FORM FACTORS BASED ON BROKEN CHIRAL SYMMETRY. Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 2: 569-72(1 Aug 1970).

A new and simpler technique is used to derive low-energy theorems on K_{l3} decay form factors $f_+(0)$ and $f_-(0)$ based on SU(3) × SU(3) symmetry breaking. The (3*,3) ⊕ (3,3*) symmetry-breaking model is employed for definiteness. Assumptions like field algebra, vector dominance, c-number Schwinger terms, or pole saturation are not used. The method yields the results of Callan and Treiman, Glashow and Weinberg, and Gerstein and Schnitzer in appropriate limits. The assumption under which the results agree with those of Dashen and Weinstein are also discussed. The sensitivity of the parameter $\xi \equiv f_-(0)/f_+(0)$ to assumptions of explicit symmetry breaking is demonstrated, and several conclusions are drawn. (auth)

45561 TIME-REVERSAL INVARIANCE AND RECOIL DEUTERON POLARIZATION IN ELASTIC ELECTRON SCATTERING. Hey, A. J. G. (Oxford Univ.). Phys. Rev., D; 2: 626-7(1 Aug 1970).

It is shown that any nonzero transverse polarization of the recoil deuteron in elastic electron-deuteron scattering must be due, in the one-photon-exchange approximation, to a violation of time-reversal invariance. This clarifies Ramachandran's conclusions. (auth)

45562 SPONTANEOUS BREAKDOWN OF WEAK AND ELECTROMAGNETIC INTERACTION SYMMETRY. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y.). Phys. Rev., D; 2: 736-42 (15 Aug 1970).

A unified theory of the weak and electromagnetic interactions of leptons and hadrons is constructed. The underlying symmetry group is taken to be the SU(2) generated by the weak lepton currents and the hadronic Cabibbo currents. This symmetry is destroyed by the spontaneous breakdown mechanism. In this theory, the weak coupling constant is the same as the electromagnetic coupling constant, and the mass of the charged intermediate boson is 37.4 GeV. (auth)

45563 SUM RULES IN NUCLEAR PHYSICS. Leonardi, R. (Univ., Bologna); Rosa-Clot, M. Nuovo Cim.; 69A: 1-9(1 Sep 1970).

The interplay between the existence of the SU_2 symmetry group in nuclei and the possibility of establishing a set of independent sum rules for the isovector excitation processes of the nucleus is discussed. (auth)

45564 CABIBBO ANGLE AND $SU_2 \times SU_2$ BREAKING. Gatto, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Ergeb. Exakten Naturwiss.; 53: 45-106(1970).

The discussion of the Cabibbo angle and SU(2) × SU(2) breaking covers leading weak divergences at lowest order, chiral symmetry breaking, leading weak divergences, the free quark model, current algebra schemes, and an alternative approach. (J.F.P.)

Applications (Strong)

45565 (NYO-2171-317) SU(3) MASS DIFFERENCES IN FIFTH INTERACTION AND TADPOLE RESULTS. Goyal, Ashok (Pennsylvania Univ., Philadelphia. Dept. of Physics). [1968]. 35p. Dep. CFSTI.

The medium strong mass splittings are examined for pseudoscalar mesons, vector mesons and spin $^3/_2$ baryons in the framework of the "fifth interaction" proposed by Ne'eman. In addition to the resonance contributions from the low lying states, an expression is written for the contribution from f_8 Regge exchange in terms of contributions to electromagnetic mass differences from A_2^0 Regge exchange. Assuming A_2^0 Regge pole gives correct contribution to the e.m. mass differences, the contribution of the f_8 meson is estimated. In the approximation of neglecting the continuum spectrum, the ratio of tadpole contributions is given by the ratio of coupling constants of f_8 meson with hadrons. The results of tadpole model are in agreement with the subtraction scheme of Segrè. It is also found that in the presence of such an SU(3) symmetry breaking term, the renormalization of hadronic-weak strangeness-changing vector current vertex, to second order in such a term, is quadratically divergent. (auth)

45566 UNSTABLE PARTICLES AND THE POINCARE SEMIGROUP. Schulman, L. S. (Indiana Univ., Bloomington). Ann. Phys. (N. Y.); 59: 201-18(Jul 1970).

Unstable particles are defined in terms of representations of a semigroup containing the Lorentz group and space–time translations into the future. The absence of backward time translations arises from the irreversibility of the decay process. Unstable particles are found to possess spin and parity labels but instead of a diagonal mass operator a coherent superposition (with more or less Breit–Wigner shape) of mass values appears. Nonexponential decay is also derived as are a number of apparently nonphysical representations with peculiar spin spectra. Some questions suggested by this formalism are briefly raised: models of unstable systems; mixing of internal and external symmetry; time reversal violation. (auth)

45567 ROLE OF THE Z*'s IN A THEORY OF CLASHING INTERNAL SYMMETRIES. Tuan, S. F. (Univ. of Hawaii, Honolulu). Contract AT(04-3)-511. Phys. Rev., D; 2: 617-18 (1 Aug 1970).

The role of the Z*'s is discussed on the basis that the badly broken nonchiral SU(2) × SU(2) internal symmetry is also relevant for the classification of hadronic states, complementing the well-established broken SU(3) symmetry. If it is assumed that the Z*'s belong to $(^1/_2,^1/_2)$ representation of SU(2) × SU(2), one or more sets of $Z_\delta^\pm$ and $Z_\eta^\pm$ is expected. Each $(Z_\delta^\pm, Z_\eta^\pm)$ set is nearly mass degenerate and has the same spin and parity. (auth)

45568 SCALAR MESONS IN BROKEN CHIRAL SYMMETRY. Pande, L. K. (Univ. of Texas, Austin). Lett. Nuovo Cim.; 4: 401-7(29 Aug 1970).

A previous method for obtaining the mass of the X^0 meson and the $\eta - X^0$ mixing angle is extended to scalar mesons. The framework of chiral SU(3) × SU(3) associated with the vector and axial vector current octet is used. (J.F.P.)

45569 MIXING OPERATOR FOR THE $SU_3 \times SU_3$ CHIRAL ALGEBRA. Buccella, F. (CERN, Geneva); Kleinert, H.; Savoy, C. A.; Celeghini, E.; Sorace, E. Nuovo Cim.; 69A: 133-49(1 Sep 1970).

A saturation scheme within an infinite set of states is proposed for the chiral algebra. Mesons are classified in the (35, any L) representations of $SU_6 \times O_3$, while the (56, L = even) and (70, L = odd) representations are chosen for baryons. A mixing operator $\exp[-i\theta Z]$ is proposed which transforms the axial charges of the SU_6 solution into the physical ones. The specific form chosen for Z gives rise to many predictions. All the axial couplings of the lower positive-parity meson states to π, ρ and ω are obtained in terms of only one parameter and the results are in fair agreement with experiment. In particular, the B-meson is predicted to decay transversely, while the g_1/g_0 ratio for the A_1 is found to be $-^1/_2$. For the $^1/_2^+$ baryon octet, we get $D/F = ^3/_2$ and $G^* = ^4/_5\, G_A$ (which implies $\Gamma_{\Delta\to N\pi} = 125$ MeV) up to second order in the mixing angle θ. For each $SU_6 \times O_3$ multiplet all the decays into $N + \pi$ are given in terms of only one parameter (at lowest possible order in the mixing angle) in general agreement with experiment. Finally, strong restrictions are obtained on the chiral content of the $^1/_2^+$ octet, which are perfectly compatible with nature. (auth)

45570 COMMENT AND REPLY ON "TESTS FOR EIGHTFOLD-WAY OCTETS IN THE BARYON SPECTRUM". Feld, B. T. (Massachusetts Inst. of Tech., Cambridge); Roberts, A. P.; Box, M. Phys. Rev., D; 2: 952-3(1 Sep 1970).

It is pointed out that the phenomenon of multiplet mixing, when there are a number of relatively close-lying resonances with the same values of the internal quantum numbers, renders inappropriate the use of the Gell-Mann–Okubo mass formula in attempting to judge the validity of the SU(3) symmetry scheme. In reply, it is noted that the argument that the Gell-Mann–Okubo mass formula is inappropriate rests on an incorrect assumption, namely, that independent of the model adopted, the existence of particle pairs with common quantum numbers makes mixing inevitable. (auth)

45571 ASYMPTOTIC SU(3) SYMMETRY AND BARYON COUPLINGS. Oneda, S. (Univ. of Wisconsin, Milwaukee); Matsuda, Seisaku. Phys. Rev., D; 2: 887-96(1 Sep 1970).

General broken-SU(3) sum rules for baryon transitions $B' \to (^1/_2)^\pm + P$ (B' denotes a nonet or octet baryon with arbitrary spin and parity) are derived. The approach is based on the use of a chiral SU(3) ⊗ SU(3) charge algebra, the hypothesis of partially conserved axial-vector current (PCAC) and, in particular, the assumption of asymptotic SU(3) symmetry formulated for the matrix elements of the vector charge V_K. The V_K is the SU(3) raising or lowering operator. The sum rules thus obtained are always compatible with the Gell-Mann–Okubo mass splittings of hadrons. They exhibit a simple modification of exact-SU(3) sum rules, but the effect is, in general, quite significant. As a specific application, the $Y_0^*(1405)$ transition is discussed in some detail in order to compare with the recent result of Gell-Mann, Oakes, and Renner (GOR), based on a different approximation for broken SU(3) symmetry. It is shown that, in the absence of singlet-octet mixing, both approaches give the same result in this particular case, and that the GOR approximation can, in fact, be derived from our asymptotic SU(3) symmetry. Our asymptotic SU(3) symmetry, however, appears to be a more general and far-reaching prescription, useful in broken SU(3) symmetry when combined with the use of equal-time commutation relations involving the charge V_K. A com-

ment is also made about the hard-kaon and η-meson extrapolation resulting from the use of kaon and η-meson PCAC. The result is applied to the derivation of the values of the ΛNK and ΣNK couplings from the experimental information on the axial-vector semileptonic couplings of hyperons. The result is consistent with experiment. (auth)

45572 SCALAR MESONS AND SUM RULES FOR f_{K^+}/f_π f_{K^0}/f_{K^+} AND $m_{\kappa^+}-m_{\kappa^0}$. Eliezer, Sh.; Singer, P. (Technion-Israel Inst. of Tech., Haifa). Lett. Nuovo Cim.; 4: 443-6 (5 Sep 1970).

An application is given of the use of SU(3) × SU(3) algebra of charges, PCAC and PCVC to obtain sum rules for f_K, f_π, and Δm_κ. It is concluded that the assumption of scalar meson dominance of the divergence of the vector currents allows a unified picture for both SU(2)- and SU(3)-breaking phenomena. (J.F.P.)

Field Theories

General

45573 REEXAMINATION OF UNIFIED FIELD THEORY. Muraskin, M. (Univ. of North Dakota, Grand Forks). Ann. Phys. (N. Y.); 59: 27-41(Jul 1970).

A nonlinear field theory with a nonsymmetric Γ^i_{jk} which has the property that all tensor functions of g_{ij}, e^q_i, Γ^i_{jk}, and ∂_k are treated in a uniform manner is studied. All scalar functions of g_{ij}, e^q_i, Γ^i_{jk} and ∂_k are constants in such a theory. If the theory is to be meaningful, it is necessary for a set of consistency conditions to be satisfied. It is, then, shown that nontrivial solutions to these consistency equations do exist. It is shown that the field equations are asymptotic to the conventional wave equation. It is found that particle-like behavior can be made to appear at an origin point. The theory does not involve any arbitrary functions. Thus, there is less arbitrariness in this theory as compared with other hyperbolic type theories. (auth)

45574 ELLIOTT SCHEME AND ITS GENERALIZATIONS. Afanas'ev, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 4: 208-15(Aug 1970). (In Russian).

The symmetry properties of the quadrupole interaction in the spherically symmetrical oscillator field are investigated. The noninvariance group of the Hamiltonian describing this interaction is found to be SO(3,2) for the two-dimensional oscillator and Sp(3,3) for the three-dimensional one. It is shown that the vibrations in the generalized model, if they were present at all in the standard model with the dipole and quadrupole forces, can be caused only by the competition effect between those forces. (auth)

Quantum Field Theory

Refer also to abstract 45604.

45575 (JINR-E2-5160) CPT AND INFINITE-COMPONENT FIELDS. Oksak, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 32p. Dep. CFSTI (U. S. Sales Only).

Concepts are presented which are of use in the analysis of covariance of quantized fields with respect to the Poincaré group involving the space-time reflection. There are fields (namely, infinite-component fields satisfying all the Wightman axioms) for which CPT-theorem fails; it is interesting therefore to search for relevant substitutes of the CPT-covariance. (auth)

45576 TIME MEASUREMENT USING A REALIZABLE ATOMIC CLOCK IN A MOVING FRAME OF REFERENCE. Stephenson, L. M. (University Coll., London). J. Phys., A (London); 3: 368-77(Jul 1970).

All realizable clocks are made up from two distinct parts. The first part consists of either an oscillatory mechanism or a device that exhibits a decay process. The second part consists of an integrating unit. The observations that may be made of a realizeable atomic clock, situated in an inertial frame of reference, are examined. It is shown that special relativity theory yields two different predicted results depending on the particular experimental arrangement of the atomic clock. It is proved that the usually quoted result does not relate to a true elapse of time in a moving frame of reference; it is obtained by placing the first part of an atomic clock in the moving frame of reference and the second part of the atomic clock in the observer's frame of reference. By analysing in detail the experiment appropriate to having a complete atomic clock in the moving frame, and an identical complete atomic clock in the observer's frame, it is shown that no discrepancy is observable in the readings of the two clocks. Thus special relativity theory requires that the measured time elapse between two given events should be the same for all observers in all inertial frames of reference. It is shown that two different time scales may be defined for a given moving frame of reference; these two time scales have been indiscriminately used in previous analyses because they have been incorrectly assumed to be the same. The invariant time scale given by the readings of identical, complete clocks assumes only a constant velocity of light; it is, therefore, the primary time scale of special relativity. The more commonly used, velocity dependent, time-scale additionally assumes a time-assigning function; this additional assumption restricts the use of what is now a secondary time scale to the class of problems involving only the steady-state radiation of electromagnetic energy. (auth) (UK)

45577 GAUGE TRANSFORMATION OF UTIYAMA. Toro, T. I. (Timisoara Univ., Rumania). Compt. Rend., Ser. A; 270: 1641-4(15 Jun 1970). (In French).

An extension of the gauge transformation of Utiyama is proposed by the introduction of a pseudoeuclidian gauge function depending upon a pair of points in the usual Minkowski space and in the ξ-space of Utiyama. Using a convenient choice of the gauge function, it is shown that the Utiyama transformation appears as a special case. (France)

45578 PARTICLE-LIKE BEHAVIOR. Muraskin, M.; Clark, T. (Univ. of North Dakota, Grand Forks). Ann. Phys. (N. Y.); 59: 19-26(Jul 1970).

The previously introduced field theory is studied by means of a finite difference approximation using a computer. Attention is focused on particle-like behavior centered at an arbitrary origin. In the two examples under consideration it is found that one kind of particle-like property induces other particle-like properties to also appear as a consequence of the dynamics. (auth)

45579 SOME ASPECTS OF THE QUANTUM THEORY OF LOCAL OBSERVABLES. Landau, Lawrence Jay. Berkeley, Calif.; Univ. of California (1969). 91p.

Thesis.

The local properties of von Neumann algebras of observables are investigated. Conditions for the validity of extended locality are derived. The connection between the duality condition and a generalization of Borchers' theorem is discussed. It is shown that the duality condition does not hold for the local algebras generated by certain generalized free fields, and that a field can be in the Borchers' class of the generalized free field without being a local function of the generalized free field. (Diss. Abstr. Int., B)

45580 SIMPLE N-REGGEON VERTEX. Lovelace, C. (CERN, Geneva). Phys. Lett.; 32B: 490-4(17 Aug 1970).

A Veneziano formula is proved for N external reggeons, no less elegant than that for scalars. It transforms neatly under twists, gauges, propagation and factorization. An operator version suggests a third quantized field theory. (auth)

45581 CONVERGENCE OF PERTURBATION THEORY FOR STATIC MODELS. James, P. B.; North, G. R. (Univ. of Missouri, St. Louis). Phys. Rev., D; 2: 695-7(15 Aug 1970).

The unrenormalized perturbation series for the charged-scalar static model with finite cutoff is shown to have a finite radius of convergence. Although only the two-point function is explicitly considered, the result generalizes to three- and four-point functions. (auth)

45582 LINEARLY RISING TRAJECTORIES IN AN INFINITE-COMPONENT FIELD THEORY. Chodos, Alan; Haymaker, Richard W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 2: 793-801(15 Aug 1970).

A particular set of infinite-component wave equations is analyzed from a non-group-theoretical point of view for the purpose of constructing a field theory. Using difference-equation techniques, equations are studied with much more general mass spectra than group theory would allow. One equation is solved exactly (corresponding to an equation previously solved group theoretically) and a model of the ρ trajectory which is asymptotically linear is analyzed. As expected, a ghost appears in the theory, but the equation is modified in a simple way which causes the ghost to disappear. (auth)

45583 QUANTA. Freund, P. G. O.; Goebel, C. J.; Nambu, Y. (eds.). Essays in Theoretical Physics Dedicated to Gregor Wentzel. Chicago; University of Chicago Press (1970). 425p.

Separate abstracts are prepared for 17 of the 19 papers included. (C.E.S.)

For abstracts of individual papers see: 45248, 45383, 45384,

45450, 45460–45462, 45500–45503, 45515, 45531, 45610–45612, and 45825.

45584 FERMIONS IN A FIELD THEORY OF CURRENTS. Genz, H.; Katz, J. (Univ., Hamburg). Nuovo Cim.; 69A: 15-36(1 Sep 1970).

Equal-time commutators between vector and axial-vector currents with fermion fields $\bar{\psi}$ are investigated under the assumption that $[Q_5^\alpha(x_0), \bar{\psi}(x)] \propto \psi(x)\gamma_5\tau^\alpha$ for the axial charges $Q_5^\alpha(x_0)$. It is shown that there must be Schwinger terms in the equal-time commutators between the time components of the currents and fermion fields $\bar{\psi}$ introduced in models of the Sugawara type. The chiral transformation properties of both the non-Schwinger and Schwinger terms are derived in a model-independent fashion. Next, assuming the equal-time commutator between the time-time component of the symmetric energy-momentum tensor and the spinor field $\bar{\psi}$ to be as in quantum electrodynamics it is shown that the number of Schwinger terms in $[V_k^\alpha(x), \bar{\psi}(y)]$ or $[A_k^\alpha(x), \bar{\psi}(y)]$ is less than or equal to their number in $[V_0^\alpha(x), \bar{\psi}(y)]$ or $[A_0^\alpha(x), \bar{\psi}(y)]$ respectively and a number of relations for the Schwinger terms are derived. In addition, the equation of motion for $\bar{\psi}$ is also derived and discussed in the Sugawara model. (auth)

45585 EXPERIMENTUM CRUCIS FOR THE PROOF OF THE SPACE-TIME ABSOLUTENESS. Marinov, S. (Inst. of Physics, Sofia). Phys. Lett., A; 32: 183-4(9 Jun 1970).

A crucial experiment which will verify the "special" space-time absoluteness is proposed. This experiment consists in the establishment of the zero transverse light Doppler effect. (auth)

45586 EQUAL-TIME COMMUTATOR IN THE LEE MODEL INCLUDING THE UNSTABLE V PARTICLE. Tadic, D.; Zovko, N. (Rudjer Boskovic Inst., Zagreb. Univ., Zagreb). Z. Phys.; 237: 121-5(1970).

A number of statements about properties relevant to the real physical theories, illustrated by the Lee model in a previous work are completed and generalised to the case with the unstable V particle. It was shown that for a general class of convergent theories the equal-time commutator of "charge" densities preserves the canonical value. (auth)

45587 EXACT CONTENT OF THE RENORMALIZATION GROUP POSTULATE. Jouvet, B. (College de France, Paris). Lett. Nuovo Cim.; 4: 413-15(5 Sep 1970).

The proper foundations of the renormalization group which can be set in two different ways are re-examined. Restriction is made to the null-mass quantum electrodynamics. (J.F.P.)

45588 ASYMPTOTIC CONDITIONS AND INFRARED DIVERGENCES IN QUANTUM ELECTRODYNAMICS. Kulish, P. P.; Faddeev, L. D. Teor. Mat. Fiz.; 4: 153-70(Aug 1970). (In Russian).

An S-matrix definition for the relativistic theory of interacting charged particles which is free from infrared divergences is suggested. This is achieved through a modification of the asymptotic condition and introduction of new space of asymptotic states. This space differs from that of Fock, but it is still separable and relativistic and gauge-invariant. The mass-operator in this space has no nonzero discrete eigenvalues. (auth)

45589 QUANTIZATION OF AN ESSENTIALLY NONLINEAR FIELD. Blokhintsev, D. I. Teor. Mat. Fiz.; 4: 145-52(Aug 1970). (In Russian).

The essentially nonlinear field implies a field obeying a certain equation with characteristics depending on the field itself and its derivatives. The simplest example of quantization of an essentially nonlinear system with one degree of freedom is first considered. Then a method of quantization of the essentially nonlinear field of the type of Born–Infeld field is described. (J.F.P.)

Gravitation and General Relativity

Refer also to abstracts 44952–44954.

45590 (JINR-E2-5271) EXTENDED PARTICLE MODEL IN THE GENERAL THEORY OF RELATIVITY. Markov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 15p. Dep. CFSTI (U. S. Sales Only).

The Einstein–Maxwell field equations allow some specific solutions; these are almost closed Friedmann worlds, the metrics of which are connected with the Nordström–Reissner metric through a narrow throat. The classical parameters of this object, the sizes of the throat, its potential and the total mass of the system $\Gamma_h = \epsilon\sqrt{n}/c^2$; $\varphi_h = c^2/\sqrt{n}$, $m = \epsilon/\sqrt{n}$ are given. These classical systems turn out to be unstable—the pair production effect in strong throat fields polarizes the initial charge of the system and classical systems with different initial charges tend (as $t \to \infty$) to one and the same almost closed system, the so-called "friedmon" with microscopic values of the total charge, sizes and the total mass. The system ("friedmon") is viewed as the extended particle model in the general relativity theory. It can also be regarded as a specific example of a model with form factor in which the signal propagates with a velocity which is smaller than the velocity of light due to an appropriate change of the metric. In the Euclidean space the form factor leads, as a rule, to the appearance of superlight signals. (auth)

45591 NEW IMPROVED ENERGY–MOMENTUM TENSOR. Callan, Curtis G. Jr. (Inst. for Advanced Study, Princeton, N. J.); Coleman, Sidney; Jackiw, Roman. Contracts AF49-638-1380; AFOSR-70-1866; AT(30-1)-2098. Ann. Phys. , (N. Y.); 59: 42-73(Jul 1970).

It is shown that the matrix elements of the conventional symmetric energy-momentum tensor are cut-off dependent in renormalized perturbation theory for most renormalizable field theories. However, it is argued that, for any renormalizable field theory, it is possible to construct a new energy-momentum tensor, such that the new tensor defines the same four-momentum and Lorentz generators as the conventional tensor, and, further, has finite matrix elements in every order of renormalized perturbation theory. ("Finite" means independent of the cut-off in the limit of large cut-off.) This tensor is explicitly constructed in the most general case. The new tensor is an improvement over the old for another reason: the currents associated with scale transformations and conformal transformations have very simple expressions in terms of the new tensor, rather than the very complicated ones they have in terms of the old. It is also shown how to alter general relativity in such a way that the new tensor becomes the source of the gravitational field, and it is demonstrated that the new gravitation theory obtained in this way meets all the experimental tests that have been applied to general relativity. (auth)

45592 CALCULATION OF THE DIFFERENTIAL SCATTERING CROSS SECTIONS OF GRAVITATIONAL INTERACTION. Tourrenc, Andre (Paris Univ.). Compt. Rend., Ser. B; 271: 1-4(6 Jul 1970). (In French).

The methods and terminology are briefly revised. Studies are made of photon–photon scattering and neutral scalar particle-photon scattering by the exchange of a virtual graviton. The results obtained from various theories are compared. (France)

45593 GRAVITATIONALLY INDUCED (MACHIAN) MAGNETIC FIELD. Ehlers, J. (Univ. of Texas, Austin); Rindler, W. Phys. Lett.; 32A: 257-8(27 Jul 1970).

The magnetic field induced by a rotating mass-shell having at its center a stationary charged sphere is calculated in the framework of linearized general relativity. (auth)

45594 SCALE INVARIANCE AND GRAVITATIONAL COUPLING. Deser, S. (Brandeis Univ., Waltham, Mass.). Ann. Phys. (N. Y.); 59: 248-53(Jul 1970).

A variant of general relativity provides a model in which scale invariance of matter is a consistency requirement on its coupling to gravitation. Invariance breaking is introduced by giving a finite (cosmological) range to one of the gravitational variables; the Einstein and cosmological constants are then approximately determined by the average mass–density of the universe. (auth)

45595 GRAVITATIONAL FIELD OF THE ELECTRON. O'Connell, R. F. (Cambridge Univ., Eng.). Phys. Lett., 32A: 402-3(24 Aug 1970).

It is shown that spin contributions to the gravitational field of an electron dominate for distances between the classical radius and the Compton wavelength of the electron. At such distances the gravitational force between two electrons may be repulsive, depending on the spin orientations. (auth)

45596 GRUNDZUEGE DER RELATIVITAETSTHEORIE. (Fundamentals of Relativity Theory). Einstein, A. Wissenschaftliche Taschenbuecher, Band 58. Berlin; Akademie-Verlag (1969). 168p.

Based on four lectures, given at Princeton University in 1921, the main principles and mathematical methods of the relativity theory are presented. Details are omitted and important aspects are emphasized. Cosmological problems and the theory of relativity for nonsymmetrical fields are presented in an appendix. (H.B.G.)

45597 SOURCE OF THE KERR METRIC. Israel, Werner (Univ. of Alberta, Edmonton). Phys. Rev., D; 2: 641-6(15 Aug 1970).

Assuming that the Kerr–Newman metric is the field of a layer

of mass and charge distributed over the equatorial disk spanning the ring singularity, the source distribution on the disk is computed explicitly. In the uncharged case, this interpretation automatically excises the noncausal parts of the manifold, so that the unique source of the causally maximal extension of the vacuum metric is obtained. A Newtonian field which gives the same source distribution is exhibited, and shown to be closely analogous to the relativistic case. In particular, the Newtonian particle orbits show the same avoidance of the ring singularity that is such a remarkable feature of geodesics in the Kerr geometry. In the charged case, it is examined how the gyromagnetic moment (which is equal to that of the Dirac electron) is reflected in the character of the source distribution. (auth)

45598 STATIONARY SYSTEMS WITH SPHERICAL SYMMETRY CONSISTING OF MANY GRAVITATING MASSES. Florides, P. S. (Trinity Coll., Dublin. Dublin Inst. for Advanced Studies); Jones, R. L. Nuovo Cim.; 69B: 41-52(11 Sep 1970).

In 1939 Einstein published a paper with the above title in which he investigated the gravitational field of a spherically symmetric system consisting of a large number of gravitating particles of equal masses moving in concentric circular orbits, randomly oriented in space, under the influence of the field produced by all the particles together. His object was to show that Schwarzschild-like singularities do not exist in cases which have physical reality. In a paper published in 1964 Misra claimed that the field equations set up by Einstein were "mixed up and erroneous" but that Einstein's final results were valid. It is shown that, although Einstein's paper is extremely confusing and contains some mistakes, Misra's criticisms are completely unfounded. A general and clear derivation of Einstein's results is given. (auth)

45599 CROSS SECTIONS FOR SCATTERING OF MASSLESS PARTICLES BY GRAVITON EXCHANGE. Peet, F. G. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 48: 923-9 (15 Apr 1970).

The gravitational scattering of various types of massless particles is considered. Cross sections are given for the gravitational scattering of scalar particles by: scalar particles, photons, four component neutrinos, and two component neutrinos; of photons by: photons, four component neutrinos, and two component neutrinos; of four component neutrinos by four component neutrinos; and of two component neutrinos by two component neutrinos. The cross section given by Barker et al. and by Boccaletti et al. for the scattering of photons by photons is confirmed. The cross section for the scattering of scalar particles by scalar particles given by DeWitt and the cross section for the scattering of photons by scalar particles given by Boccaletti et al. are found to be in error. (auth)

Scattering Theory

Refer also to abstracts 45035, 45505, 45516, and 45580.

45600 (COO-1746-37) OFF-ENERGY-SHELL T-MATRIX FOR LOCAL POTENTIALS WITH SINGULAR CORE INTERACTIONS. II. TENSOR AND COULOMB FORCES. Kim, Y. E.; Tubis, A. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. 31p. Dep. CFSTI.

A previous derivation of an integral equation, which gives the complete off-energy-shell t-matrix for two-body scattering via local potentials with singular core interactions, is generalized to include the effects of tensor and Coulomb forces. The core interaction is described by the boundary condition model (specified energy-independent logarithmic derivative of the radial wave function at the core radius). The formalism is now being applied to the calculation of tri-nucleon bound-state and scattering parameters using the Faddeev formalism and realistic nucleon-nucleon forces. (auth)

45601 NONLOCAL POTENTIALS AND THEIR LOCAL EQUIVALENTS. Coz, Marcel; Arnold, Louis G.; MacKellar, Alan D. (Univ. of Kentucky, Lexington). Ann. Phys. (N. Y.); 59: 219-47(Jul 1970).

The transformation of the radial Schrödinger equation for a nonlocal potential to the radial Schrödinger equation for a local potential is investigated. Previous work is clarified and extended to complex values of the wave number. For the purpose of establishing a correspondence between the properties of the nonlocal and local equations, the nonlocal equation is studied in the coordinate representation. In connection with this study, it is shown that the so called spurious state solutions to the nonlocal equation can be attributed to the breakdown of the linear independence of solutions which behave asymptotically as incoming and outgoing waves. The method used to transform the nonlocal equation leads to unique expressions for the equivalent local potential and damping function throughout the domain of definition of the solutions to the nonlocal equation. Both bound states and the continuum are treated by the same method. The transformation is limited by the appearance of the spurious solutions to the nonlocal equation. In the absence of such solutions, the nonlocal and local wave functions have the same phase and the same number of nodes; they differ only by the damping function which is an everywhere positive amplitude factor. For a nonlocal kernel which is real and symmetric, the nonlocal and equivalent local equations have the same spectrum. In this case, the damping function is unity at the origin. The method described is relevant to several problems of current interest. (auth)

45602 RISING REGGE TRAJECTORIES. Epstein, Gary Martin. Riverside, Calif.; Univ. of California (1969). 125p. Thesis.

A bootstrap or unique calculation of a linearly rising Regge trajectory is attempted in single-channel, single-trajectory model when postulates of analyticity permit dispersion relations to be separately written for both the trajectory and the logarithm of its associated reduced residue function. The trajectory is caused to rise by making two subtractions in its dispersion relation; the reduced residue is subtracted just once as in potential theory. For the case of the rho-trajectory, the two dispersion relations are coupled through elastic unitarity resulting in a rather complicated nonlinear integral equation for the imaginary part of the trajectory which must be solved by numerical iteration on the computer. The value of one of the three arbitrary subtraction constants is fixed to make the trajectory pass through the rho. (TSS)

45603 FACTORIZATION OF SATELLITE TERMS IN THE N-PARTICLE DUAL AMPLITUDE. II. THE SINGLE PLANAR DUAL LOOP. Frampton, P. H.; Rivers, R. J. (Univ. of Chicago). Phys. Rev., D; 2: 691-4(15 Aug 1970).

The amplitude for a single planar dual loop is written for a loop constructed from a factorized N-particle dual amplitude with satellite terms included. The endpoint essential singularity, already present in the nonsatellite case, is strengthened by the increased degeneracy of the states, and there is no possibility of canceling the singularity by manipulating the satellite coefficients. (auth)

45604 SCALE INVARIANCE, CONFORMAL INVARIANCE, AND THE HIGH-ENERGY BEHAVIOR OF SCATTERING AMPLITUDES. Gross, David J. (CERN, Geneva. Princeton Univ., N. J.); Wess, J. Phys. Rev., D; 2: 753-64(15 Aug 1970).

The constraints placed by scale invariance upon the asymptotic behavior of scattering amplitudes, in theories with no dimensional coupling constants, are discussed. It is proved that for a wide class of Larangian theories, which include all renormalizable interactions except for ϕ^3 coupling, scale invariance implies invariance under conformal transformations. The equations that scattering amplitudes should satisfy in theories where the breaking of scale invariance is due solely to nonzero masses are derived, under the assumption of large energies compared to the masses. These equations are derived by two methods, first by direct scale and conformal transformations of the Green's functions and second by considering the low-energy theorem for the emission of the divergence of the currents which generate scale and conformal invariance. These divergences are essentially given by the trace of the symmetric energy-momentum tensor. A low-energy theorem is proved for the emission of an energy-momentum tensor (or graviton) from an arbitrary process up to quadratic terms in the graviton momenta. The equations of scale and conformal invariance are applied to the scattering of scalars off spinors, and photons. It is argued that scale invariance leads to asymptotic behavior that is governed by fixed cuts and not by Regge poles in the angular momentum. Although the strong interactions seem to be manifestly non-scale invariant, scale and conformal invariances may prove useful in discussing asymptotic behavior in quantum electrodynamics, in model field theories, and in high-energy inelastic electroproduction. (auth)

45605 RELATION BETWEEN THE MULTI-REGGE MODEL AND THE AMATI-BERTOCCHI-FUBINI-STANGHELLINI-TONIN PION-EXCHANGE MULTIPERIPHERAL MODEL. Chew, Geoffrey F.; Rogers, Terence; Snider, Dale R. (Univ. of California, Berkeley). Phys. Rev., D; 2: 765-80(15 Aug 1970).

The 1962 Amati–Bertocchi–Fubini–Stanghellini–Tonin (ABFST) multiperipheral model, with a kernel based on an up-to-date guess for the elastic $\pi\pi$ cross section, is used to illuminate certain controversial concepts that have arisen in multi-Regge models. The small magnitude of the elastic $\pi\pi$ cross section above the region of prominent resonances is related to the small diffraction-dis-

sociation cross section and to the small Pomeranchon coupling constant in the Chew–Pignotti (CP) model. Although lower trajectories in the multi-Regge kernel give an inadequate representation of low-subenergy resonances, it is shown that an artificial CP-model input can be found which roughly simulates the resonance component of the ABFST kernel. By-products of our investigations are (1) a generalization of the Berestetsky–Pomeranchuk formula that provides a practical basis for exact numerical evaluation of the ABFST model at any energy, and (2) a perturbative analysis of diffractive dissociation (d.d.) which reconciles a small d.d. cross section at accessible energies with a total cross section that becomes entirely of the d.d. type in the extreme high-energy limit. (auth)

45606 COMMENT ON THRESHOLD KINEMATIC CONSTRAINTS AND CORRELATIONS OF HELICITY AMPLITUDES. Franklin, Jerrold (Temple Univ., Philadelphia). Phys. Rev., D; 2: 811(15 Aug 1970).

Previously derived threshold constraints on helicity amplitudes are simplified for high-spin cases, using a suggestion made by King and Kuo. (auth)

45607 CROSSING REGGE TRAJECTORIES AND POLE-CUT RELATIONSHIPS. Oehme, Reinhard (Univ. of Chicago). Phys. Rev., D; 2: 801-5(15 Aug 1970).

The general features of typical pole-cut relationships with crossing Regge-pole trajectories are considered. The possible shapes of the resulting physical pole trajectories are described. (auth)

45608 VALIDITY OF THE RELATIVISTIC EIKONAL APPROXIMATION. Tiktopoulos, George; Treiman, S. B. (Princeton Univ., N. J.). Phys. Rev., D; 2: 805-10(15 Aug 1970).

The relativistic eikonal formula for high-energy scattering, discussed recently by a number of authors, rests on a certain technical approximation concerning the high-energy behavior of sums of generalized ladder graphs. This approximation is shown to be justified, in the sense that it preserves the leading energy behavior in the sum over all generalized ladder graphs of a given order. (auth)

45609 LAPLACE TRANSFORMS AND THE DIAGONALIZATION OF BETHE–SALPETER EQUATIONS FOR ABSORPTIVE PARTS. Abarbanel, H. D. I.; Saunders, L. M. (Princeton Univ., N. J.). Phys. Rev., D; 2: 711-16(15 Aug 1970).

A Laplace transform is developed for the crossed-channel partial-wave analysis of Bethe–Salpeter-like equations for the absorptive part of scattering matrix elements. The transform requires no assumption about rotating contours to a Euclidian region and allows from the outset power growth in energy of the transformed absorptive part. This eliminates the need for any analytic continuation after the transformation. The diagonalization of the forward and nonforward equations with arbitrary irreducible kernels is explicitly carried out. (auth)

45610 THEORY OF THE EIGENVALUES OF THE S-MATRIX. Goldberger, M. L.; Jones, C. E. (Princeton Univ., N. J.). pp 209-46 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

The general analytic properties of the eigenvalues of the S-matrix describing n coupled two-body channels are discussed. The important role of singularities of the eigenvalues resulting from the coincidence of eigenvalues for complex energies is treated in detail. It is shown that considerable insight into the underlying dynamics, in particular, the importance of high threshold channels on lower ones can be obtained from an eigenphase analysis of data. A kind of Levinson theorem is derived. (auth)

45611 RELATIVISTIC COMPLEX POLE MODEL WITH INDEFINITE METRIC. Lee, T. D. (CERN, Geneva). pp 260-308 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

A relativistic complex pole model with an indefinite metric is described. The model enables one to study in detail scattering processes involving multiple exchanges of these negative metric quanta, corresponding to Feynman diagrams with one or more closed loops. The usual Feynman integration paths have to be modified, and the general rule for such modifications is given. The implication for causality of these multiple exchange processes is discussed. (auth)

45612 FORWARD DISPERSION RELATIONS AND MICROCAUSALITY+ Oehme, Reinhard (Univ. of Chicago). pp 309-37 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

A brief review is given of the structure of forward dispersion relations and of their derivation on the basis of microcausality, spectral conditions, and other basic notions of relativistic field theory. After a short discussion of the global aspects of local commutativity, the effects of possible violations of microcausality are studied. Modified dispersion formulas are derived under the assumption of exponentially decreasing bounds for the matrix elements of commutators in space-like directions. Simple mathematical models are considered in order to study qualitatively the implications of possible acausal singularities. (auth)

45613 AMPLITUDE FOR THREE-PARTICLE PRODUCTION AT HIGH ENERGIES AND LARGE MOMENTUM TRANSFERS. Ansel'm, A. A. (Ioffe Inst. of Physics and Tech., Leningrad); Lipatov, L. N.; Winbow, G. A. Nuovo Cim.; 69A: 57-79(1 Sep 1970).

A study is made of the asymptotic nature of the amplitude for three-particle production at high energies and large momentum transfers. Simple assumptions are made about the nature of the discontinuities across the cuts in the complex-angular-momentum plane, similar to those which, in the case of elastic scattering, resulted in qualitative agreement with experiment. By means of a summation of the contribution of branch points, explicit expressions are obtained for the production amplitudes (formula (36)), similar to the expression for an elastic amplitude (an exponential drop in the amplitude with momentum transfer with superimposed oscillations). In the last section a potential model is developed similar to the eikonal approximation for the case of elastic scattering. With certain limitations there occurs a certain generalization extended to the three-particle case of the usual eikonal formula (formula (54)). A relationship is established between the potential model developed and summation of the contribution of branch points in complex angular momentum. (auth)

45614 ABSOLUTE BOUND ON THE $\pi\pi$ SCATTERING AMPLITUDE. Wit, R. (CERN, Geneva). Nuovo Cim.; 69A: 10-14(1 Sep 1970).

Combining unitarity with the well-known properties of the Herglotz functions an essential improvement on the upper bound of $|F(2, 2, 0)|$ is obtained under the additional assumption $F(4, 2, -2) < 0$. (auth)

45615 OFF-MASS-SHELL VENEZIANO-TYPE AMPLITUDE COMPATIBLE WITH PCAC AND BROKEN CHIRAL SYMMETRY. Yoneya, T.; Kanazawa, A.; Haruyama, M. (Hokkaido Univ., Sapporo). Lett. Nuovo Cim.; 4: 459-63(5 Sep 1970).

It is demonstrated that the Csikor-type amplitude with a single satellite term is sufficient to satisfy all the off-mass-shell constraints by current algebra while it is still compatible with the model of Gell-Mann and others. (J.F.P.)

45616 INVESTIGATION OF THE EQUATIONS FOR REGGE POLE PARAMETERS. Amatuni, A. Ts.; Garyaka, A. P. (Erevan Inst. of Physics). Teor. Mat. Fiz.; 4: 202-7(Aug 1970). (In Russian).

For the system of equations for Regge pole parameters derived by Sheng, Sharp, and Mandelstam a proof is given of the existence and uniqueness of the solution under a certain condition which couples all the constants. For the proof the theorem of Kantorovich and Akilov is used essentially. The fulfilment of the conditions of this theorem ensures the contraction property of the mappings. (auth)

Particle Accelerators

Refer also to abstracts 43986, 44244, 44289, 44291, 44308, 44374, 44515, and 44516.

45617 (AERE-R-6353) THE DESIGN AND IMPLEMENTATION OF A REGENERATIVE BEAM EXTRACTOR FOR THE 110" HARWELL SYNCHROCYCLOTRON. West, D. (Atomic Energy Research Establishment, Harwell (England)). Jul 1970. 42p. Dep. CFSTI (U. S. Sales Only). UK 7s.

The design and installation of a regenerative beam extraction system for the Harwell 110-inch Synchrocyclotron is described. Extensive use was made of orbit computer programs, in conjunction with magnetic field surveys, both in the design and installation stages of the work. An extracted beam of 59 nanoamperes (3.7×10^{11} protons per sec.) at an energy of 159 MeV was obtained from an internal beam of 2 microamperes. (auth) (UK)

45618 (AWRE-O-29/70) ION BEAM SLOW PULSING INJECTOR SYSTEM FOR A 2MV VAN DE GRAAFF. Emmons, S. G.; Howe, F. A.; James, G. (Atomic Weapons Research Es-

tablishment, Aldermaston (England)). Jun 1970. 12p. Dep. CFSTI (U. S. Sales Only). UK 2s.

An ion beam slow pulsing facility has been developed and installed in the high voltage terminal of the Imperial College 2 MV Van de Graaff. Pulsed ion beams are obtainable with a pulse repetition rate variable between 200 and 1000 c/s. The pulse length is variable between 50 and 10 μs to maintain a space/signal ratio of 100/1 ± 15%. The largest pulsed current obtained to date is 0.80 μA, while for dc operation a resolved beam of deuterons (or protons) after deflection by an analyzing magnet of 60 μA has been obtained. (auth)

45619 (BNL-14808) R20 VARIABLE APERTURE COLLIMATOR MECHANICAL CONSTRUCTION AND MANUAL CONTROL. Repeta, L. E.; Curtiss, J. A. (Brookhaven National Lab., Upton, N. Y.). 2 Jun 1970. 28p. Dep. CFSTI.

The design of an adjustable four-jaw collimator for slow beam extraction from the Brookhaven AGS is given. Equipment for remote manual control and position readout is described. (W.H.K.)

45620 (BNL-14974) ROOM-TEMPERATURE LONG-PULSE RF BEAM SEPARATORS. Brown, H. N.; Hahn, H.; Halama, H. J.; Lazarus, D. M.; Sandweiss, J. (Brookhaven National Lab., Upton, N. Y.). 15 Jul 1970. 42p. Dep. CFSTI.

The production of purified beams of elementary particles in the momentum range from 5 to 15 GeV/c suitable for counter spark-chamber experiments at the Brookhaven AGS is discussed. Two general methods have been considered: (1) use of a chain of sixteen conventional iris-loaded deflectors, and (2) the major aspect of this report, the use of a long dielectric-loaded deflector. The need for a strong magnetic focusing channel around the deflector and its effect on the particle motion is discussed. A specific beam optical system from target to beam stopper with a solid angle close to 600 μsr is suggested, and the expected separated particle fluxes are calculated. The deflecting properties of a rectangular waveguide loaded symmetrically with BeO are discussed and the required tolerances are determined. A microwave system for the long-pulse separator is presented in detail sufficient for a budgetary cost estimate. It is concluded that room-temperature long-pulse rf beam separators are technically feasible and could be operational within 2 to 3 years. (auth)

45621 (CERN-70-15) PLANNING OF CERN PROJECTS WITH THE HELP OF THE PERT METHOD. Anderson, T.; Blondel, J.; Brouwers, L.; Chevallier, G.; Gayral, J.; Guyomar, J. C.; Lecomte, A.; Leroy, E.; Leroy, G.; Minder, G. (European Organization for Nuclear Research, Geneva (Switzerland)). 12 May 1970. 53p. (In French). Dep. CFSTI (U. S. Sales Only).

The manner in which the PERT method is used for the management of CERN projects is described. A general idea is given of the program written for the CDC 6600/6500 computers. The program is in CERN-FORTRAN (compatible with ASA FORTRAN IV) and requires 41 K of memory (60 bits/word). A complete example of its use, the installation of the SS56 for CPS ejection, is given. (J.S.R.)

45622 (CERN-70-22) PHASE ACCEPTANCE OF QUADRUPOLE TRIPLETS IN TERMS OF MATRIX ELEMENTS. Regenstreif, E. (Rennes Univ. (France). Faculte des Sciences. European Organization for Nuclear Research, Geneva (Switzerland)). 24 Jul 1970. 73p. Dep. CFSTI (U. S. Sales Only).

Analytic expressions are derived, allowing one to determine the phase space contour and area of a general triplet. It is shown that there are nine possible configurations for the phase space contour in the focusing-defocusing-focusing plane and four possible configurations for the phase space contour in the defocusing-focusing-defocusing plane. In all cases the acceptance areas can be obtained by means of relatively simple formulae involving easily calculable matrix elements. It should be stressed however that in the focusing-defocusing-focusing plane the acceptance area is expressible in terms of the matrix elements of the whole triplet, whereas in the defocusing-focusing-defocusing plane the matrix elements of either the entrance doublet or the exit doublet or both do appear in the acceptance formulae. Moreover, in the defocusing-focusing-defocusing plane it is possible, under certain conditions (which have been worked out analytically) to replace the triplet by a doublet, entirely equivalent to the triplet from the point of view of the accepted contour and area. Extension of the theory to the quadruplet shows that there are nine possible configurations for the phase space contour in each plane of the quadruplet. The formulae giving the accepted areas have been framed so that they can be used independently of the main body of the paper. (auth)

45623 (CERN-Trans-70-5) PROBLEMS OF CONTROLLING ACCELERATORS BY DIGITAL COMPUTERS. Andryushchenko-Lyutsenko, N. I.; Vasil'ev, A. A.; Dzergach, A. I.; Kuz'min, V. F.; Rubchinstsii, S. M.; Solov'ev, G. N. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated for CERN, Geneva, Switzerland, from report NTD-6821. 7p. Dep. CFSTI (U. S. Sales Only).

Expediency of controlling an accelerator by digital computers is pointed out. Basic problems of proton synchrotron control being solved by computers are considered, including those of monitoring of accelerator systems, automatic control and optimization of operating modes, and generation of programmed control signals on the basis of information derived from the accelerated beam. (auth)

45624 (CONF-691101) SECOND INTERNATIONAL CONFERENCE ON ACCELERATOR DOSIMETRY AND EXPERIENCE, STANFORD LINEAR ACCELERATOR CENTER, CALIFORNIA, NOVEMBER 5-7, 1969. (Division of Operational Safety (AEC), Washington, D. C. Stanford Linear Accelerator Center, Calif.). 872p. Dep. CFSTI.

Separate abstracts were prepared for 38 of the 50 papers presented. The remaining 20 papers previously appeared in NSA. For abstracts of these papers see CONF-691101 in a cumulative report number index. (W.H.K.)

For abstracts of individual papers see: 44243, 44244, 44290–44292, 44327, 44403, 44474, 44475, 44515, 44516, 44538, 44965, and 45625–45649.

45625 (CONF-691101–, pp 1-10) THE EXPANDING USE OF PARTICLE ACCELERATORS IN RESEARCH, MEDICINE, AND INDUSTRY. Burrill, E. Alfred.

It is estimated that there are well over 2,200 particle accelerators in use or under construction throughout the world, as of the end of 1968. The vast majority of these machines provide particle energies below 100 MeV. This population is increasing at a rate of about 10% per annum, and with few exceptions these new accelerators are commercially manufactured. About half the total population is installed in the U.S.A., of which only about 28% are used for nuclear science and engineering. The proliferation of accelerators into other areas has raised questions concerning the desirability of developing standards of accelerator design and definitive recommendations on radiation protection. The continuing study of the expanding use of particle accelerators is therefore of importance, to ensure compatibility between the various objectives of the accelerator users, and the safe design and performance of their equipment and facilities. (auth)

45626 (CONF-691101–, pp 11-20) A COMPACT 4 MeV LINEAR ACCELERATOR FOR USE IN CANCER THERAPY. Austin, N. A.; Lawrence, D. C.; Nylander, R.; Penning, D. (Varian Associates, Palo Alto, Calif.).

A 12 inch long standing-wave 4-MeV electron linac, operating at 3000 MHz, for radiotherapy is described. Design of the Clinac 4 x-ray target head is included. Characteristics, operational features, and safety features are described. (W.H.K.)

45627 (CONF-691101, pp 42-62) CALCULATION OF NUCLEAR REACTIONS FOR INCIDENT NUCLEONS AND π-MESONS IN THE ENERGY RANGE 30 TO 2700 MeV. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.).

The two-step intranuclear cascade–evaporation approach is used in the calculation of nuclear reactions for incident nucleons and π-mesons in the energy range where the production of π-mesons is important. The model of the target nuclei includes the effects of the diffuse nuclear boundary, the motion of the bound nucleons, and the exclusion principle. The calculated inelastic cross sections, particle multiplicities, energy spectra, angular distributions, and radiochemical cross sections are compared with experiment, and reasonable agreement is found, in general, over broad incident particle energy ranges and target mass values. Even though the agreement found in the present set of comparisons is very encouraging, additional comparisons must be made to clearly delineate the areas where the model may or may not reproduce experimental results. (auth)

45628 (CONF-691101–, pp 70-91) CALCULATION OF THE RESIDUAL PHOTON DOSE RATE DUE TO THE ACTIVATION OF CONCRETE BY NEUTRONS FROM A 3-GeV PROTON BEAM IN IRON. Armstrong, T. W.; Barish, J. (Oak Ridge National Lab., Tenn.).

Calculations have been carried out to determine the time dependence of the residual photon dose rate inside an accelerator tunnel due to a 3-GeV proton beam located on the axis of an iron cylinder. The photon dose rate produced by the activation of the concrete tunnel wall is calculated and combined with the results from a prevoius calculation for the dose rate contributed by the iron to obtain the total photon dose rate inside the tunnel. The effectiveness of lowering the total photon dose rate by reducing

the ^{24}Na production in the concrete is evaluated. The development of the nucleon–meson cascade, the residual nuclei production, and the photon transport are calculated using Monte Carlo methods. (auth)

45629 (CONF-691101–, pp 92–8) BEAM CURRENT LIMITS IN THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Fulmer, C. B.; Ball, J. B.; Lord, R. S.; Livingston, R. S. (Oak Ridge National Lab., Tenn.).

Beam current limits, based on residual radiation levels, were determined for protons, deuterons, helium-3, and alpha particle beams in the Oak Ridge Isochronous Cyclotron. The basis for setting the limits is that the radiation level, due to radioactivity induced by beam loss in the extraction system, should be the same after sixteen hours cooling for the various particle types and range of energy. The energies extend to 40 MeV for deuterons, 65 MeV for protons, and 80 MeV for helium-3 and alpha particles. All of the significant radioactivities were taken into account. Excitation functions, based on experimental data, were used. A computer code was used to perform the residual radiation calculations. Maximum permissible beam losses were thus determined for the present ORIC extraction system which consists of components of carbon, aluminum, copper, and tantalum. The effects on the beam current limits of variation of cooling times and bombardment times were also explored. Similar calculations were made for all-copper extraction system. (auth)

45630 (CONF-691101–, pp 99–110) RADIOACTIVITY PRODUCED AND RELEASED FROM WATER AT HIGH ENERGIES. Warren, G. J.; Busick, D. D.; McCall, R. C. (Stanford Linear Accelerator Center, Calif.).

The $^{15}O/^{11}C$ ratio was measured in two accelerator beam dump cooling water systems: a water dump where 90% of the electromagnetic shower develops in water and a water-cooled copper dump. The activity ratio ($^{15}O/^{11}C$) in each system was the same but corrected saturation activities are considerably different: 13/1 for the water dump and 1.6/1 for the copper dump. The difference has not been explained. (W.H.K.)

45631 (CONF-691101–, pp 111–20) RADIATION HAZARD OF INDUCED ACTIVITY IN AIR AS PRODUCED BY HIGH ENERGY ACCELERATORS. Haefert, M. (European Organization for Nuclear Research, Geneva (Switzerland)).

In view of the planned tenfold increase in intensity of both CERN accelerators (Proton Synchrotron of 28 GeV and Synchrocyclotron of 600 MeV proton energy) the problem of the potential radiation hazard is discussed taking into account the latest experimental results and questioning the validity of formerly published $(MPC)_a$ (maximum permissible concentration in air) values. Concentrations of active gas up to 27 pCi/cc were found in the ventilated machine halls one minute after machine stop, and even higher values were measured in the unventilated target areas of extracted proton beams. The main isotopes detected are ^{15}O, ^{11}C and ^{13}N, and small amounts of ^{41}Ar in places where thermal neutrons are present. The isotope percentages, as determined by analyzing the decay curves, are relative to the accelerator operation time and ventilation rate. With the submersion and subsequently the dose to the whole body as the limiting factor—according to the ICRP—the $(MPC)_a$ values for the positron emitters calculated earlier differed by a factor of two. Doses originating from typical isotope mixtures encountered in the CERN accelerator halls were measured with LiF and films and found to be in good agreement with the calculated values. New values for the $(MPC)_a$'s of the positron emitters are given, with not only the beta absorption with depth in tissue, but also the size of the radioactive cloud in which the body is submerged taken into account. It is shown that in all practical cases the critical organ is represented by the skin and earlier calculations made on $(MPC)_a$ values are rather conservative. (auth)

45632 (CONF-691101–, pp 139–45) OPERATIONAL HEALTH PHYSICS ASSOCIATED WITH INDUCED RADIOACTIVITY AT THE STANFORD LINEAR ACCELERATOR CENTER. Busick, D. D.; Warren, G. J. (Stanford Linear Accelerator Center, Calif.).

Experience at SLAC with the machining of hardware which has been activated by exposure to a high energy e^- or e^+ beam and high energy secondary particles produced by the absorption of the primary beam is discussed. The composition of most beam line components is typically aluminum, copper or stainless steel. Such items as vacuum pipes, valves, beam dumps, targets, beam scrapers and bellows are typical of the types of hardware involved. Equipment such as large Faraday cups, calorimeters and secondary emission quantometers are also involved. An approach to establishing operational guidelines for personnel protection is discussed. (W.H.K.)

45633 (CONF-691101–, pp 209–21) CASCADES INDUCED BY 4 GeV ELECTRONS IN CONCRETE. Coleman, F. J. (Daresbury Nuclear Physics Lab. (Eng.)); Shaw, K. B.; Stevenson, G. R. (Rutherford High Energy Lab., Chilton (Eng.)).

Experiments at the 5 GeV electron synchrotron NINA have provided initial information on the lateral and longitudinal development of the electron induced cascade in typical shielding materials. Activation detectors, thermoluminescent detectors and ionization chambers were used for measurements of the lateral extent of the cascade at various depths. Additonal information was obtained from scans of the activity induced in the shield materials. From the measurements of specific activities in the detectors and of dose rates, conclusions are drawn regarding the ratio between the hadron and photon components of the total dose rate at various depth locations. Some comparison is made with existing data from different experimental configurations. (auth)

45634 (CONF-691101, pp 253–301) A SOLUTION TO THE TRANSVERSE SHIELDING PROBLEM FOR HIGH-ENERGY (> 0.8 GeV) ELECTRON AND PROTON ACCELERATORS. O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

The energy distribution of the neutron current emitted normally to a stopped high-energy electron, photon or proton beam is essentially independent of the beam energy, and is very soft. By combining the softness of the secondary spectrum (which makes it possible to neglect neutrons above 0.5 GeV, as well as all protons, mesons and muons) with the invariance of spectral shape, a single set of multi-group equations for the neutron flux and dose-equivalent penetrating the shielding parallel to the stopped beam of an accelerator has been derived. These equations have been solved for iron and for a variety of materials approximating earth and concrete in their composition, and are valid for the side shielding of particle beams above 0.8 GeV. This solution has been compared with experimental data obtained at Brookhaven and at CERN during the CERN/LRL/RHEL collaboration, with side-shielding calculations of Alsmiller and Ranft, with experimental data obtained at the Cambridge Electron Accelerator and at Princeton, and with spectral measurements made by the Health and Safety Laboratory. As a result it is plain that this solution is capable of yielding results which are as accurate as the experimental measurements, and in reasonable agreement with other calculations. The theory is explicitly dependent on the geometry of the accelerator and its power. Because of its simplicity it easily lends itself to guiding calculations for design purposes and as a supplement to experiments. (45 references.) (auth)

45635 (CONF-691101–, pp 302–22) BREMSSTRAHLUNG FROM THICK TUNGSTEN TARGETS BOMBARDED WITH HIGH-ENERGY ELECTRONS. Berger, Martin J.; Seltzer, Stephen M. (National Bureau of Standards, Washington, D. C.).

The emission of bremsstrahlung from thick tungsten targets bombarded by electrons with energies between 10 MeV and 60 MeV has been calculated by a Monte Carlo method. The treatment includes all generations of the electron–photon cascade in the target. The results obtained include (1) the bremsstrahlung efficiency as a function of the target thickness and of the incident electron energy; (2) the transmission of electrons through the target; (3) the angular distribution of the emitted bremsstrahlung intensity; (4) the spectra of the bremsstrahlung emitted at various angles with respect to the direction of the incident electron beam; (5) energy deposition by electrons in the target at various depths; and (6) the photon flux spectrum as a function of the depth within the target. The Monte Carlo calculations required a substantial but not prohibitive amount of computing effort, and have been shown reliable by comparisons with various experimental results. (58 references). (auth)

45636 (CONF-691101–, pp 341–8) DTF SHIELDING CALCULATIONS AT 800 MeV–LAMPF. Israel, H. I.; Cochran, D. R. F. (Los Alamos Scientific Lab., N. Mex.).

The DTF-IV discrete ordinates transport code has been applied to the calculation of the required transverse shielding for the accelerator structure of the Los Alamos Meson Physics Facility. Basic cross section input data for the calculation are generated by a Monte Carlo cascade code and are also taken from the LRL-LASL tape library of neutron cross sections. Because of computer memory limitations, an approximate analytic expression is used for the source term of neutrons generated by the stopping of 800-MeV protons in copper. Both the source and transport computations include the effects of anisotropic scattering. Several conservative assumptions in the calculation cause the resulting effective dose rate attenuation length to be somewhat longer than that computed in one other specific comparison calculation. (auth)

45637 (CONF-691101–, pp 377–93) HIGH ENERGY ACCELERATOR SHIELDING STUDIES IN JAPAN. Katoh, Kaznaki

(Japan Atomic Energy Research Inst., Tokai); Doke, Tadayoshi (Tokyo Univ. (Japan). Inst. for Nuclear Study).

In Japan, studies of radiation shielding for high energy accelerators have been scarcely made except for the work of the study group of the GeV-range proton synchrotron project. Results of the shield design for the temporarily proposed 8 GeV proton synchrotron are introduced briefly. Experiments on the sky-shined neutrons from a 50 MeV proton cyclotron, measurements of the attenuation lengths of neutrons from a thick Cu target bombarded with protons of 50 MeV for several shielding materials, spectroscopy of neutrons over a wide energy region with solid state track detectors, and some new concepts which were made for the convenience to shielding works of high energy accelerators, are also stated. (auth)

45638 (CONF-691101–, pp 416-34) CALCULATION OF BEAM LOSS DISTRIBUTIONS AND RADIATION DOSES ON MAGNETS IN PROTON SYNCHROTRONS. Ranft, J. (Rutherford High Energy Lab., Chilton (England)).

Beam losses in proton synchrotrons and the resulting radiation doses on magnets are investigated by Monte Carlo calculations. The scattering of primary protons in the septa of ejection systems and beam scrapers is considered. From the momentum and angular distributions of the scattered primary protons and secondary particles, the loss distribution around the ring is calculated. The possibility of using beam scrapers to concentrate beam losses is investigated, and their efficiency is estimated. The energy deposited in the magnet units by the lost protons, (radiation dose), is calculated with the help of a Monte Carlo nucleon–meson cascade calculation. The radiation doses calculated for magnets downstream of internal targets and ejection septa of the CERN-PS agree roughly with measurements. The method can be used to predict radiation doses on corresponding magnets of the 200 to 300 GeV accelerators. (30 references) (auth)

45639 (CONF-691101–, pp 435-9) LAWRENCE RADIATION LABORATORY ACCELERATOR SAFETY PROGRAM. Rich, Bryce L.; Kase, Kenneth R. (California Univ., Livermore. Lawrence Radiation Lab.).

A brief description of the LRL accelerator facilities, examples of procedural variance, and a description of a uniform LRL safety guide for all accelerator facilities are presented. (W.H.K.)

45640 (CONF-691101–, pp 440-6) BEAM STOP STUDIES AT THE BROOKHAVEN AGS. Levine, Gerald S.; Moore, William H. (Brookhaven National Lab., Upton, N. Y.).

Shielding properties of a beam stop consisting of a steel parallelepiped surrounded by concrete were studied in a show external beam of 10^{12} protons at 28 GeV/c at the Brookhaven AGS. Data are presented on the attenuation of strongly interacting particles in the beam stop and distribution of the strongly interacting cascade in the beam stop. The detectors used in the study are briefly described. (W.H.K.)

45641 (CONF-691101–, pp 595-608) RADIATION PROBLEMS AROUND THE DESY 7 GeV ELECTRON ACCELERATOR. Tesch, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany).

The dosimetry of the accelerator-produced radiation is considered. First of all, a few data on the accelerator are given. Then the basic concept of radiation protection measurements is described, which is somewhat different from the measuring methods used at other accelerators. Experience and instruments to perform all stray-radiation measurements around the accelerator are described. Two methods are reported which are under development to extend the range of neutron dosimetry to 10 to 100 MeV. Rem-responding instruments are used. One method combines the detector designed by J. W. Leake with another ^{3}He-counter surrounded by an 18" sphere of polyethylene. In addition, a liquid scintillator is tried as a neutron dosimeter; pulses due to electrons are rejected by pulse-shape discrimination. (auth)

45642 (CONF-691101–, pp 609-18) RADIATION HAZARD NEAR HIGH-ENERGY ACCELERATORS AND OCCUPATIONAL EXPOSURES. Dutrannois, J.; Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)).

The occupational radiation records of the CERN staff —a large research laboratory working only in the field of high-energy physics —have been analyzed for the last ten years of operation of the accelerators. Statistical data on the exposure of individuals for this period are presented and discussed in the light of the evolution of the Laboratory. In particular, information about the total personnel yearly dose required to run the Laboratory is given along with the average individual exposures and overexposures. The distribution of the average dose amongst the staff and also its relation to the type of work as well as to the rules in force at the corresponding periods are analyzed. In spite of the fact that individual monitoring is limited to those occupationally exposed, it is shown that the number of persons receiving more than 1.5 rem per year represents only a few per cent and this is compatible with what is found in other establishments where occupational radiation hazard exists. It is pointed out that the results obtained have not been achieved by reinforcing the rules and regulations for radiation protection, which could slow down the work output, but rather by improving the engineering and in particular by a better planning of the projected work. In conclusion, radiation problems that will be created by the presently planned higher accelerator intensities will not be unsolved if the two aforesaid conditions are correctly applied. (auth)

45643 (CONF-691101–, pp 619-24) RADIATION LEVELS ADJACENT TO CITY STREETS CLOSE TO THE CAMBRIDGE ELECTRON ACCELERATOR. Maddox, B. J.; Shapiro, J.; Shurcliff, W. A. (Harvard Univ., Cambridge, Mass.).

Because the 6-GeV Cambridge Electron Accelerator is situated within 15 ft of city streets and within 60 ft of several dwellings, especially close control of radiation emerging from the Circular Tunnel is required. By employing five types of area monitors of neutron and gamma radiation and by imposing appropriate restraints on accelerator operating procedures, we have succeeded in keeping the total annual dose at these streets below 100 mrem, which is one-fifth of the dose permitted by government regulations. (auth)

45644 (CONF-691101–, pp 625-47) THE PRESENT STATUS OF INSTRUMENTATION FOR ACCELERATOR HEALTH PHYSICS. Sullivan, A. H. (European Organization for Nuclear Research, Geneva (Switzerland)).

The various possible principles on which a measurement of radiation hazard can be based, derived from the ICRP definition of dose equivalent, are discussed. In practical accelerator health physics considerations other than precision are often important, such as portability, simplicity, and immunity from saturation effects in pulsed radiation fields. The instruments in use to make a rapid measurement of radiation hazard are described. Where a more precise measurement is required, it becomes necessary to divide the radiation field up into a number of components and measure each component separately. The various instruments of sufficiently well defined response that are used in such analyses are described. The differences both in instrumentation and methods of interpretation that exist between different laboratories are discussed. Instruments and methods aimed at making as precise measurements as possible of dose equivalent are also described. These methods either involve a measurement of LET spectra, or a measurement of some LET-independent parameters, and absorbed dose, or are based on determining sufficient parameters of the radiation field such that dose equivalent can be calculated. (65 references.) (auth)

45645 (CONF-691101–, pp 672-83) DOSE MEASUREMENTS AT THE NORDIC BETATRONS AND LINEAR ACCELERATORS. Svensson, Hans; Hettinger, Gunnar (Umea Univ. (Sweden). Dept. of Radiation Physics).

In 1968, a special dose measurement program was carried out at therapeutic accelerators at 12 laboratories in Denmark, Finland, Norway and Sweden. With uniform instrumentation and techniques, the dose at the dose maximum, relative depth dose curves and isodose curves were determined for electron- and x-radiation of different qualities incident upon a water phantom. The measurements were made with ionization chambers, photographic films and ferrous sulphate dosimeters. The primary electron and photon fluence within the radiation beam was studied with photographic films at depths of 2 and 5 cm, respectively. For electron radiation, the 90% isodensity curves covered an area that ranged from 20% to 90% of the geometrical field size. The energy of the electron radiation was determined both by range analysis and by studying the thresholds of (γ,n) reactions. Good agreement was obtained between these two methods when a correction was applied for the electron energy degradation in the tube window, scatter foils and transmission chamber. (auth)

45646 (CONF-691101–, pp 684-91) ANGULAR DISTRIBUTION OF THICK TARGET BREMSSTRAHLUNG. McCall, R. C.; Nelson, W. R. (Stanford Linear Accelerator Center, Calif.); Wyckoff, J. M.; Pruitt, J. S. (National Bureau of Standards, Washington, D. C.).

The angular distributions of dose due to 30 and 57.4 MeV electron beams striking a thick Ta target have been measured using

small thermoluminescent detectors. Depth-dose curves measured at 5 and 135° have been used to demonstrate the contribution of secondary electrons in free air, at a plexiglas surface and at 9.25g/cm^2 inside the plexiglas. Comparisons are made with calculated angular distributions of the photon energy emitted showing fair agreement. (auth)

45647 (CONF-691101–, pp 764-75) COMPARISONS BETWEEN DOSE RATE MEASUREMENTS WITH PROTONS, DEUTERONS, HELIUM IONS, AND HEAVY IONS AT THE HEIDELBERG TANDEM AND EMPEROR VAN DE GRAAFF ACCELERATORS. Festag, J. G. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).

The dose rates and doses are given as measured with ^{1}H, ^{2}H, ^{3}He, ^{4}He, ^{6}Li, ^{12}C, ^{16}O, ^{19}F, ^{32}S, and ^{35}Cl during the operation of the two Tandem van de Graaff accelerators (type EN and MP). G.-M. counters with plastic envelopes are used to measure the γ-dose; the neutron doses are determined mainly by Bonner-detectors. Values are given as measured inside the concrete caves at a distance of about 3 metres from the target or Faraday cup and outside the 1 m concrete shielding. The instantaneous dose rates with a constant current are compared with the average dose rates for the entire interval of one complete experiment with the same current. The variation in the dose rates are examined under the same conditions for the nuclear physics experiment. The dose rates are given in the region from 39 to 60 MeV for ^{12}C ions, from 39 to 78 MeV for ^{16}O ions, and from 39 to 110 MeV for ^{35}Cl ions. The dose per μCb is also given for angles of 42°; 57.5°, and 90° to the beam axis. Also, γ-dose during the conditioning of the accelerators were studied. (auth)

45648 (CONF-691101–, pp 782-808) BEAM SAFETY CONSIDERATIONS AT THE STANFORD LINEAR ACCELERATOR CENTER. Busick, D. D.; Jenkins, T. M.; McCall, R. C.; Nelson, W. R.; Svensson, G. K.; Warren, G. J.; Baumgarten, A.; Harris, J. L.; Murray, J. J.; Seppi, E. J.; Vetterlein, R. J. (Stanford Linear Accelerator Center, Calif.).

The planning and operational phases of radiation protection at SLAC are described with regard to: (1) primary electron and positron beam containment; (2) control of dangerous secondary beam areas, or ones that are potentially dangerous; (3) radiation and shielding calculations; (4) beam check-out procedures and measurements; and (5) routine monitoring. Several classic examples illustrate the ingenuity required to satisfy the safety criteria established at SLAC. (W.H.K.)

45649 (CONF-691101–, pp 836-42) BEAM STOP FOR 28 GeV/c PROTONS. Levine, Gerald S.; Moore, William H. (Brookhaven National Lab., Upton, N. Y.).

Shielding properties of a beam stop consisting of a steel parallelepiped surrounded by concrete were studied in a slow external beam of 10^{12} protons at 28 GeV/c at the Brookhaven AGS. Data are presented on the strongly and weakly interacting particle flux density distributions in the beam stop. The nuclear emulsions and scintillation counter telescopes used in the study are briefly described. (W.H.K.)

45650 (COO–1760-3) SUMMARY REPORT ON CYCLOTRON UTILIZATION, OPERATIONAL ACHIEVEMENTS, AND IMPROVEMENTS. Technical Progress Report During Twelve Months Ending May 31, 1970. Shull, Franklin B. (Washington Univ., St. Louis, Mo.). 15 Jul 1970. Contract AT(11-1)-1760. 21p. Dep. CFSTI.

Operation and development of the cyclotron laboratory at Washington University, St. Louis, Missouri, are summarized. Cyclotron use and operational achievements are described. Particle energies and some maximum currents achievable are listed. (W.H.K.)

45651 (INR–1187) 10-MeV PROTON LINEAR ACCELERATOR. Zespolowa, Praca (Institute of Nuclear Research, Warsaw (Poland)). 1970. 68p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Principles of operation and main technical data of the proton linear accelerator built in the Institute of Nuclear Research at Swierk are given. This report describes in a condensed form all basic problems of design, construction and start-up of the machine. (auth)

45652 (JINR–P9-5129) ON CALCULATION OF FIELDS, INPUT IMPEDANCE, CURRENTS, AND TENSION IN THE LINEAR INDUCTION ACCELERATOR INDUCTORS. Bukaev, P. V.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 41p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Some characteristics of the linear induction accelerator inductors are considered. The calculation of the electrical and magnetic fields, elements of the equivalent conversion circuit, and input impedance of the inductors and sections, which is based on the substitutions of distributed parameters by lumped ones, is presented. Transfer and frequency characteristics of the inductor and section are determined. The chain of a high-current impulse circuit with non-uniform forming line and stray induction is considered. Final expressions for tensions and currents in the exciting and secondary windings of inductor are obtained. The pictures and calculation curves of tension and current in a primary inductor windings are presented. (auth)

45653 (KFK-tr–318) NONLINEAR INTERACTIONS OF AN INTENSIVE BEAM OF CHARGED PARTICLES WITH THE ACCELERATING FIELD. Lomize, L. G.; Murin, B. P.; Kvasha, A. I.; Filipchikov, L. L. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from report NTD-6910-R. 7p. (In German). Dep. CFSTI (U. S. Sales Only).

The nonlinear interactions of an intensive beam of charged particles with the accelerating field were theoretically studied by the derivation of relations describing such interactions. The relations obtained were experimentally tested with an input operation of the I-100 injector of the Serpukhov synchrotron at a beam current of 80 mamp and an initial equilibrium phase of 37°. The theoretical and experimental values for α (the ratio of the voltage drop on the basis of the beam charge to the initial voltage in the circuit) were compared. If the measurement errors of α and the formation of coherent oscillations in the accelerator are considered, then the agreement between theory and experiment can be considered satisfactory. (J.S.R.)

45654 (KFK-tr–319) STABILITY OF A BEAM STANDING IN INFERIOR QUALITY IN RECIPROCAL ACTION WITH A RESONATOR. Derbenev, Ya. S.; Dikanskii, N. S. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from Preprint 326. 11p. (In German). Dep. CFSTI (U. S. Sales Only).

The coherent transverse stability of a short beam which is in interaction with a low-quality resonator was investigated. It was shown that this interaction can lead to the so-called "instabilities without memory." (tr-auth)

45655 (PTB–2/70) THE SIGNAL-TO-NOISE RATIO FROM A COMPACT CYCLOTRON IN A PRECISION TIME-OF-FLIGHT SPECTROMETER. PART I. (x,n) REACTIONS. Jahr, R. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Mar 1970. 15p. (In German). Dep. CFSTI (U. S. Sales Only).

A precision time-of-flight spectrometer is proposed, in which an incident charged particle beam from a compact cyclotron can be turned around the target, while the time-of-flight path for measuring the emerging neutrons remains fixed. The signal-to-noise ratio for neutrons which reach the detector situated at the end of the time-of-flight path, is discussed. (auth)

45656 (SLAC-Trans–118) DETERMINATION OF THE MAXIMUM (PEAK) ELECTRIC FIELD IN DISK-LOADED WAVE-GUIDES IN THE E_{01} MODE. Zykov, A. I.; Kotov, V. I.; Yampol'skii, I. R.; Smolin, V. I.; Kolot, Z. M.; Smirnov, V. L. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated by T. Watt for Stanford Linear Accelerator Center, Calif., from report KHFTI–69-23. 15p. Dep. CFSTI.

The method of small perturbations has been used to measure the ratio of the maximum electric field to the accelerating field in disk-loaded traveling-wave waveguides, and also the values of R/Q in the range of a/b = 0.25 – 0.40, for modes $\psi = \pi/2, 2\pi/3, 3\pi/4$; with λ_0 = 10.71 cm, and disk thickness t = 4 mm (t/λ_0 = 0.0374). (auth)

45657 (UCRL–18595) EXCITATION OF A CLOSED CYLINDRICAL CAVITY BY A CHARGED RING MOVING ALONG THE AXIS AT CONSTANT VELOCITY. Levine, Barbara S.; Sessler, Andrew M. (California Univ., Berkeley. Lawrence Radiation Lab.). 10 Feb 1969. Contract W-7405-eng-48. 3p. (CONF-690308–8). Dep. CFSTI.

From Particle Accelerator Conference, Washington, D. C.

An important aspect of the design of high-current devices is the beam loading of the accelerating structure. The phenomenon is sensitive to the charge distribution of the beam and to the geometry of the structure. Calculations for realistic geometry are difficult; to gain insight, a number of authors have studied the simplified problem of beam interaction with a closed, right cylindrical cavity. A formal solution, for arbitrary charge distribution, has been given as a (double) sum over the modes of the cavity. It has been emphasized by all previous workers that the

simplified problem approximates reality only for those modes having wavelengths large compared to the holes in an actual structure. We have developed a computational program aimed at evaluating the energy transfer to the cavity when the geometry of the beam is characterized by inner and outer radii as well as an axial length. Sums over selected sets of (or all) modes are available. Parametric studies are presented of the total cavity excitation by a charged ring. (auth)

45658 (UCRL-19815) SYNCHROTRON RADIATION AND RING FORMATION IN THE ELECTRON RING ACCELERATOR. Pellegrini, C. (California Univ., Berkeley. Lawrence Radiation Lab.). 13 May 1970. Contract W-7405-eng-48. 14p. (CONF-700908-1). Dep. CFSTI.

From 2nd National Conference on Particle Accelerators, Moscow, USSR.

We discuss the possibility of using synchrotron radiation to form electron rings having a very high electric field to hold the ions inside the ring. The formulas describing how the energy and the dimension of the ring change under the effect of synchrotron radiation are derived, and a numerical example is given. (auth)

45659 WINDING AND TESTING OF A 10-cm SUPERCONDUCTIVE QUADRUPOLE FOR CERN. Williams, J. E. C. (Oxford Instrument Co. Ltd., Eng.); Asner, A.; Cornish, D. N. Cryogenics; 10: 278-85(Aug 1970).

The construction and testing of the first of a pair of quadrupole magnets, designed for use as superconductive beam handling elements at CERN, is described. Tests showed this magnet to be eminently suitable for nuclear physics applications. (auth) (UK)

45660 AN EVALUATION OF WINDING TECHNIQUES AND Nb-Ti WIRES FOR A SUPERCONDUCTING QUADRUPOLE MAGNET. Hassenzahl, W. V.; Laquer, H. L.; Novak, J. K.; Rogers, J. D. (Los Alamos Scientific Lab., N. Mex.). Cryogenics; 10: 319-22(Aug 1970).

A number of Nb-Ti superconducting wires for use in a quadrupole magnet have been evaluated in a mock-up configuration. These tests have included variations in insulation, helium cooling, channels, winding techniques, copper to superconductor ratio, number of superconducting filaments, short sample critical current, wire size, and wire twisting. The most significant parameters for obtaining the design current at near 30 kG central field was found to be the short sample critical current and twisting of the conductor. One conductor performed reasonably well without having been twisted. (auth) (UK)

45661 ANALOG-DIGITAL COMPLEX FOR CALCULATING FIELDS AND TRAJECTORIES OF CHARGED PARTICLES. Grigorishin, I. L.; Minervina, N. B. (Electronic Lab., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk; No. 2, 91-6 (1970). (In Russian).

A design is given of analog-numerical complex for resolving problems of electron corpuscular optics. The complex uses the computer Promin not only as a computing device but also as a program-control block with external memory assembled of a net of resistances storing the field equations as potentials in the net point nodes. The alogorithm was based on the method of consequent calculations of charged particle trajectories along the elementary cells on the differential screen and on the consequent turning of the computer towards the net of resistances in order to receive the information on the field intensity in the cells. The described assembly used a small electronic computer. (R.V.J.)

45662 IRON-FREE INDUCTION-TYPE LINEAR ACCELERATOR. Pavlovskii, A. I.; Gerasimov, A. I.; Zenkov, D. I.; Bosamykin, V. S.; Klement'ev, A. P.; Tananakin, V. A. At. Energ. (USSR); 28: 432-4(May 1970). (In Russian).

Induction-type linear accelerators, which accelerate the particles by electric fields induced by the synchronous change of the flux in the ferromagnetic cores of the transformers, are widely used for creating high-intensity and high-voltage electron currents. The transformed power may be considerably increased and the construction and the overall costs of the system may be greatly reduced if the iron core could be eliminated. Such an iron-free system was designed and tested. Its components included a condenser, controlled dischargers, and a toroidal magnetic conductor which confines the alternating magnetic flux created by the discharge of the condensers. The several keV electrons were injected from a diode, using a coaxial generator as the voltage source. The condensers were charged in a pulsed mode within 5 μsec. The device was used to accelerate plasma electrons. Fast-electron currents of about 4×10^3 A were recorded. The electron beam from the accelerator was also injected into a betatron-type magnetic field, further accelerating it to several tens of MeV. (TTT)

45663 RESONANCE ACCELERATION OF OSCILLATOR BEAM IN A PLANE-WAVE FIELD. Krasovitskii, V. B. At. Energ. (USSR); 28: 434-5(May 1970). (In Russian).

The oscillator created by charged particles in an external magnetic field may be accelerated by the field of a plane monochromatic wave to high energies if the initial field frequency is equal to the gyrofrequency. The effect of the accelerating current on the field must be taken into account when calculating the elementary acceleration process by the one-particle approximation method. This effect becomes large when the energy density of the accelerating current reaches a level comparable with that of the accelerating field and thus disrupts the acceleration. The maximum energy acquired by the beam depends on the initial amplitude of the accelerating field and the beam density. On this basis, the resonance acceleration of oscillator beams by plane, circularly polarized waves was examined, neglecting the supplementary polarization current induced by the beam. Calculations were also carried out to determine the conditions under which this approximation may be applied. (TTT)

45664 ATTENUATION OF NONLINEAR SYNCHROTRON OSCILLATIONS OF TWO CLUSTERS IN THE CASE OF THE INTERACTION OF THE BEAM WITH A RESONATOR. Kononenko, S. G.; Shenderovich, A. M. At. Energ. (USSR); 28: 436-8(May 1970). (In Russian).

The beam-resonator system acts as a negatively connected unit and thus may result in the attenuation or antiattenuation of the oscillations of a cluster or of the center of "gravity" of the beam. Similar effects were examined in the case of the relative motion of particles but in earlier studies a linear approximation has been used for the analysis. Therefore, the motion of 2 clusters was investigated by considering the oscillations of the clusters as they interact with the resonator. The derivations revealed that this interaction creates a nonlinear "friction" which may result in the attenuation or antiattenuation of the relative oscillations of the 2 clusters. The effect becomes very strong and even at relatively low amplitudes of 30 to 60° it reaches the same order of magnitude as the attenuation of the center of gravity. The conditions for attenuation or antiattenuation were determined. It was found that the energy of relative oscillations in case of attenuation is dissipated at the walls of the resonator. (TTT)

45665 ESCAPE OF RADIATION BEYOND THE LIMITS OF THE SHIELD OF THE JOINT INSTITUTE'S SYNCHROCYCLOTRON. Aleinikov, V. E.; Kimel, L. P.; Komochkov, M. M.; Sidorin, V. P. At. Energ. (USSR); 28: 438-9(May 1970). (In Russian).

Determination of the dimensions of the safe shielded area of proton accelerators on the basis of the maximum permissible dose depends on the characteristics of the radiation source, such as the geometry of the system, type of the emitted radiation, and its spectral and angular distribution; propagation of the radiation in the air beyond the shield is also of great importance. This problem was studied by determining the escape of fast, intermediate, and thermal neutrons from the external shield wall of the 660 MeV synchrocyclotron of the Joint Institute. The wall thickness of the $52 \times 32 \times 32$ m synchrocyclotron is 2 m. With the exception of the southwestern one, all walls are backed by an ~10 m high earth embankment; the top is covered by a one meter thick layer of concrete, sand, and slag. Proportional counters were used to determine the fast, intermediate, and thermal neutron fluxes escaping through the roof and the side walls of the shield. The results indicated that the openings are the chief sources of radiation escaping from within the shield; they are responsible for about 50 to 60% of the total neutron flux of various energy levels escaping to areas accessible to workers. The data may be used to design shields for high-energy proton accelerators. (TTT)

45666 DEFORMATION OF THE FOUNDATION OF THE SERPUKHOV ACCELERATOR AND ITS EFFECT ON THE SHAPE OF THE EQUILIBRIUM ORBIT. Novak, V. E.; Runov, I. V.; Khanamiryan, A. E.; Shukeilo, I. A. At. Energ. (Ussr); 28: 439-41(May 1970). (In Russian).

Each of the 120 components of the Serpukhov accelerator within the 500-m diameter circular tunnel is mounted on a steel girder placed on 2 massive reinforced-concrete foundations. The units were mounted with a precision of ±0.1 mm in the transversal and 1.0 mm in the azimuthal direction. It was found that the electromagnet blocks shifted because of the deformation of the soil. The Central Russian Plateau in which the accelerator is located is a seismically quiet zone. The studies revealed that the limestone supporting the foundation is subject to periodic vertical deformations, reaching 1 mm. These deformations are due to the variations of the ground water level and to seasonal changes in the heat balance. Construction and assembly work also contributed to the deformations; building of the concrete shield and installation of the equipment in the channels counteracted the lifting of the foundation caused by the excavation. The radial and vertical distortions of the orbit may be calculated from the shift of the magnetic

blocks. On the basis of this data, the effective vertical aperture was shortened by 15% and the radial to a somewhat lesser extent. No distortions of the orbit are anticipated in the near future. (TTT)

45667 PREMIERE CONFERENCE INTERNATIONALE SUR LES SOURCES D'IONS, 18–20 JUIN 1969. (First International Conference on Ion Sources, June 18–20, 1969). Saclay, France; I. N. S. T. N. (1970). 671p. (CONF-690625).

Separate abstracts were prepared for 51 of the 55 papers presented. The remaining 4 papers previously appeared in NSA. (W.H.K.)

For abstracts of individual papers see: 44165, 44204, 44350–44356, 44979, 45109, 45110, 45257–45259, 45276–45279, and 45668–45699.

45668 PROPERTIES OF AN H-F ION SOURCE PLACED IN A LONGITUDINAL UNIFORM INDUCTION MAGNETIC FIELD. Benoit-Cattin, Pierre; Vacquie, Serge; Mazars, Jean (Centre de Physique Atomique et Nucleaire, Toulouse). pp 41-51 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The close dependence of the evolution of the characteristics of a H-F ion source inside a longitudinal magnetic field on that of the properties of the H-F discharge is shown: the critical magnetic field B_c, and the threshold of the discharge instabilities. For $B \sim B_c$, the current intensity extracted from the source is maximum and the angular width of the beam is minimum. For $B \simeq B_c$, the energy dispersion and the energy difference (between the principal energy and the extracted energy) are maximum; they decrease rapidly when B is greater than B_c. A judicious choice of the magnetic field value allows an enhancement in the extracted intensity, and a decrease in the beam angular width with a rather weak energy dispersion. (auth) (France)

45669 CHARACTERISTICS OF A RADIO-FREQUENCY ION SOURCE WITH CENTRAL CONSTRICTION AND RADIAL EXTRACTION. Abdelaziz, Mohamed E.; Hanna, Alfonse A. (Atomic Energy Establishment, Cairo). pp 53-63 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A study of the low pressure r-f plasma has shown that the radial ionization density which is maximum at the plasma axis is inversely proportional to the square of the plasma tube radius. A suggestion based on this result led to the design of an r-f proton source with a reduced diameter in the middle of the plasma tube. Measurement of the radial density distribution has shown an increase by a factor of about 1.7 due to constriction. The ion source characteristics are determined under different conditions. (auth) (France)

45670 LONG-LIVED RADIOFREQUENCY ION SOURCE OF LOW-POWER CONSUMPTION. Nagy, J. L. (Kossuth Univ., Debrecen, Hungary). pp 65-74 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The operating characteristics of a radiofrequency ion source—with extraction electrodes situated outside of the discharge tube—have been investigated. The positive ion current was measured as a function of the H_2-gas pressure, extraction voltage, transverse magnetic field, and electrode geometry. A focused ion beam of an intensity of 200 μA and of ~60% H_1 ion content was obtained when having a transverse magnetic field about 40 Gauss, gas consumption of 2.5 cm^3/hour and a total rf-input of about 40 W into the discharge. The total electric power of 200 W, including ion-extraction and focusing, was supplied by a 400 c/s generator of small size. The excellent stability for many hundred hours and the whole mechanical construction rendered it possible to use the source reported in a 1 MeV pressurized small size Van de Graaff accelerator. The generator equipped with this source yielded 40 to 50 μA current on the target. (auth)

45671 ION-OPTICAL PROPERTIES OF THE MAGNETRON ION SOURCE. Marsicanin, Bozidar S. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). pp 75-81 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The emittance of the magnatron ion source was measured in two perpendicular planes. Using an electrostatic deflection method, the beam was scanned over two slits and the corresponding signal displayed on the oscilloscope. For the extraction voltage of 15 kV, the emittance amounts to about 70 Mrad mm. (auth))

45672 TWO PRINCIPLE MODES OF DISCHARGE IN A DUOPLASMATRON SOURCE. Lejeune, Claude (CNRS, Orsay, France). pp 83-99 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

An analysis of the ionized discharge medium in a duoplasmatron source allowed a model to be proposed explaining the basic phenomena in the discharge. Though elementary, this model makes possible a qualitative and semi-quantitative interpretation of the properties of the source, such as the interpretation of the optimum ion current extraction and the source gas yield by changing the discharge mode. This is then used to study systematically the parameters determining the optimum conditions for construction and operation. For the best yield of the ion intensity extracted I_1, it was necessary to find a gas flow rate ($N_0 \simeq I_1/e$) first, and then the values of arc intensity as well as the field B corresponding to the change in the discharge mode. These sets of values are such that $I_A \cdot B \simeq$ constant. A choice between the various values possible results in different losses in the expansion region and changes of emittance and depends upon source geometry. (France)

45673 NEW RESULTS ON AN INTENSE REFLEX DISCHARGE SOURCE OF H^- IONS. Baribaud, M.; Bliman, S.; Dolique, J. M.; Zadworny, F. (Univ., Grenoble, France). pp 111-27 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A steadily reproducible beam was extracted from the source. The intensity of the H^- ion beam was higher than 4 mA, with a current density of more than 2 mA/cm^2 and a H^- density greater than 10^{14} cm^{-3}. The H^- ion beam was studied in terms of the discharge parameters (heating power, arc current and voltage, hydrogen flow rate, intensity of the extracted beam, magnetic field) of the source geometry and of the extraction voltage. A theoretical study of H^- ion formation was made. The comparison between theoretical and experimental results can be done in a finite range depending on the outer parameters of the source; results are often in good agreement but differences appear. (auth) (France)

45674 NEGATIVE HYDROGEN IONS SOURCE. Golubev, V. P.; Komarov, V. L.; Tsepakin, S. G. (Scientific Research Inst. of Electrophysical Apparatus, Leningrad). pp 129-32 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

Static and dynamic characteristics of a duoplasmatron-type negative hydrogen ion source were investigated and the phase characteristics of a H_1^- beam were measured. Results are given. (W.H.K.)

45675 DUOPLASMATRON TYPE OF H^- ION SOURCE. Dubarry, Michel; Gautherin, Guy (Faculte des Sciences, Orsay, France). pp 133-47 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A source was built in order to vary the distance between the intermediate electrode axis and the anode axis, and between the intermediate electrode and the anode, measured along the axis. The existence of a sheath of H^- ions at the arc periphery suggested a slit geometry. Reproducible 300 μA H^- ion currents were obtained with a 3 A arc current. The order of magnitude of the number of collisions/m^3/s is given for various formation and destruction reactions taking place inside the source. (auth) (France)

45676 NEGATIVE ION SOURCE WITH CHARGE EXCHANGE IN LITHIUM VAPORS. Delaunay, B. (CEN, Saclay, France). pp 149-58 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The source is of the column type. The various parameters defining the operating conditions are discussed: pressure inside the positive ion source, temperature of the oven, pressure in the channel of the charge exchange system, pressure in the analysis area, and the energy of He^+ and H^+ incident ions. Experimental

data of negative ion spectrum analysis under various operating conditions are given with either hydrogen or lithium vapors as exchange target. A 164 hour continuous operation with $^7Li^-$ has shown the stability and reliability of this source. (auth) (France)

45677 STUDIES ABOUT THE PERFORMANCE OF A SECONDARY EMISSION ION SOURCE FOR NEGATIVE IONS. Hortig, Guenther; Mueller, Michael (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 159-64 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The operation and performance of a secondary emission source of negative ions are discussed. Positive noble gas ions (Kr) bombard a metal surface (Cu or Cr), which results in negative ion emission. The metal target disc is slowly rotated in the residual gas atmosphere to allow regeneration of the target by adsorption of residual gases. Mass spectra of negative secondary ions emitted from copper and chromium targets are presented. Also, the effect of the target surface composition on the negative ion yield is discussed. (W.H.K.)

45678 ION SOURCES IN LARGE ACCELERATORS. Lapostolle, P. (CERN, Geneva). pp 165-77 of Premiere Conference internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The principal characteristics required from ion sources used in accelerators are specified. A new definition is given of the idea of beam emittance and brightness in connection with the phase space measurement techniques. The problem of emittance-acceptance adjustment with a space charge is posed, taking into account the special details of accelerator theory owing to their direct effect on the performances required from the sources. Synchrotrons and, especially, strong focusing synchrotrons are investigated. (auth) (France)

45679 MEASURING TECHNIQUE OF ION BEAM PHASE CHARACTERISTICS. Abroyan, M. A.; Golubev, V. P.; Solnyshkov, A. I.; Tarvid, G. V. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). pp 179-85 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The phase characteristics of an ion beam are measured either with the four-slit technique or with the two-slit technique. The equipment used in both cases is described. The first technique is suitable for exact measurement of the phase volume and the phase density distribution. The entire beam is cut into narrower beams by means of a pair of movable slits or a diaphragm system and are recorded on films and examined with a photometer. When it is concerned with the beam emittance measurement only, the two-slit technique is used. The first slit is substituted by a diaphragm with a small aperture and the second one by two grid-current collectors. An oscillogram gives the diagram of the current density distribution in the beam cross section. (auth) (France)

45680 CHARACTERISTICS OF THE AGS HIGH BRIGHTNESS ION SOURCE. Sluyters, Th. J. M. (Brookhaven National Lab., Upton, N. Y.). pp 211-18 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The duoplasmatron ion source for the Brookhaven AGS is described. The geometry of the extraction region and construction details of the filament are diagramed. Typical parameters of the source for 150 mA beams are summarized. (W.H.K.)

45681 ION SOURCE OF DUOPLASMATRON TYPE. Komarov, V. L.; Solnyshkova, Z. G.; Tarvid, G. V.; Tsepakin, S. G. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). pp 219-21 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The developed ion source is intended to generate ion beams of light gases and is used in direct current accelerators. The characteristic of its design is the use of metallo-ceramic junctions and metal seals, which allows to warm up the source under vacuum for inner surface outgassing and ensures close coaxiality of source details and high efficiency. Optimum source parameters at continuous operation with small currents in the beam are investigated. (auth) (France)

45682 PULSED DUOPLASMATRON. Abroyan, M. A.; Tokarev, G. M. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). pp 223-7 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The design and operation of a duoplasmatron-type ion source for accelerators are described. Beam phase characteristics of the source are briefly discussed. (W.H.K.)

45683 ARC ION SOURCE WITH "COLD CATHODE" WITH ELECTRON OSCILLATION IN MAGNETIC FIELD. Chemyakin, G. V.; Komarov, V. L.; Tsepakin, S. G. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). pp 271–5 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I.N.S.T.N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A general description and operating specifications for a cold cathode arc ion source with electron oscillation in a magnetic field are given. The arc ion source is designed for use in direct current accelerators. (W.H.K.)

45684 CALUTRON ION-SOURCE FOR THE HARWELL SYNCHROCYCLOTRON. Scanlon, J. P. (Atomic Energy Research Establishment, Harwell, Eng.). pp 295-301 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The development of a hot filament calutron ion source as part of the improvement program for the Harwell synchrocyclotron is described. Problems encountered and results of initial tests are discussed. (W.H.K.)

45685 MERCURY POOL CATHODE APPLIED TO ION SOURCES. Dawton, Ralph (Rutherford High Energy Lab., Chilton, Eng.). pp 303-9 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The mercury pool cathode has been found to have a very long life. Three different designs are described, the first is the original simple version built for a negative ion source, the second was specifically designed for operation in a Van de Graaff high pressure enclosure, and the third was for a duoplasmatron source to be used in a helium negative ion injector. Comments on the performance of the mercury cathode with various gases including hydrogen, oxygen, and hydrogen sulphide are included. (auth)

45686 R.F. ION SOURCE OF HEAVY ELEMENTS. Komarov, V. L.; Tsepakin, S. G.; Chemyakin, G. V. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). pp 383-6 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The source is supplied with vapor from melted elements (P,Sb), solid compounds ($AgCl$, $AlBr_3$), liquid compounds (BBr_3, $SiCl_4$, $SbCl_5$, PCl_3) or gases (Ar, O_2, He, N_2, Cl_2 etc.). It provides a beam of P^+, Sb^+, Ag^+, Al^+, B^+, Si^+, Ar^+, O^+, O_2^+, He^+, N^+, Cl^+ ions after magnetic separation. A scheme and the main results obtained for an operation on gases (Ar, O_2) and on the compounds mentioned above are given. (auth) (France)

45687 PRODUCTION OF ION BEAMS OF VARIOUS ELEMENTS BEGINNING WITH THE PLASMA JET LEAVING THE DUOPLASMATRON. Masic, R.; Warnecke, R. J.; Sautter, J. M. (Thomson-CSF, Centre de Recherches, Corbeville, France). pp 387-99 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

An ion source using the post-ionization phenomenon to produce various ions, especially metallic ones, has been developed. This source is obtained from the duoplasmatron, the structure of which is conserved except that the anode is extended by a special expansion cup. This source, named (SDM), is described and the first experimental results obtained are presented. (auth) (France)

45688 HOLLOW CATHODE ION SOURCE. V. Sidenius, G. (Univ. of Copenhagen). pp 401-11 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A description of a new model of the high temperature hollow cathode ion source is given. With this ion source it is possible to remove the discharge chamber unit from the ion source body in less than a minute without breaking the vacuum in the accelerator or the high pressure surrounding it if the accelerator is placed in a tank. Test results are given for the normal electrode configuration, HCIS-A, with extraction from the anode and magnetic plasma focusing. Also, a novel principle of plasma formation is discussed, namely the hollow cathode ion source with extraction from the cathode and geometrical plasma focusing, HCIS-C. A theoretical analysis of the new principle and some experimental results are given. These led to a design of a very small and simple ion source for very high temperatures and currents up to 1 mA. The new ion source does not need any external magnetic field and may, with its overall dimensions of only 25 mm diameter and 35 mm length, be placed opposite an extraction electrode wherever in a vacuum system an ion beam is wanted. (auth)

45689 SPUTTERED ION GUN. Hill, K. J.; Nelson, R. S.; Francis, R. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 413-24 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A sputtered ion gun is reported. The various parts of the assembly are described, especially the liquid cooling system and the various arrangements of the source material on the sputtering electrode. Voltage and current characteristics are plotted. This gun is compact, easy to handle and its power requirements are small, it may operate satisfactorily in any orientation and has been pressure tested externally at 40 kg/cm^2. It serves as a universal source of ions, and provides particularly good yields of Pt, Ir, Pd and Au which have no stable compounds. The gun has functioned successfully on a number of accelerators. (auth) (France)

45690 STUDY OF A Li^+ ION SOURCE PRODUCED BY SURFACE IONIZATION. Remy, Michel (Laboratoire de Physique des Milieux Ionises, Nancy). pp 437-44 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The surface ionization phenomenon was used in order to build a source of Li^+ ions with a rather important flow rate and a long lifetime. The construction of such a source involved two difficulties. First, few metals have a work function greater than the Li ionization potential; second, an overlapping of the ionization surface by alkaline atoms may occur. These problems are solved by using a Re emissive surface. The metal has a work function greater than Li ionization potential, has a total chemical inertia against Li and is most refractory so that the temperature may be chosen sufficiently high to operate without too much overlapping. Owing to efficiency and dimensions, a capillary type emitter was chosen. The capillary is heated by electron bombardment and the reservoir by heat conduction from the capillary for long lasting operation. The capillary-reservoir system is used without a heat reflector, but for a high rate operation heat reflectors made of polished sheets are arranged around the reservoir. (auth) (France)

45691 ION BEAM PRODUCTION BY ELECTRON BOMBARDMENT OF A SOLID TARGET. Blaha, Alex (Technical Univ., Bratislava). pp 445-8 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A thin slab of a given material was bombarded with a fine pulsed electron beam to produce an ion source of reduced diameter and strong intensity. The possibility of focusing a fine electron beam (10^{-4} cm diameter) and the reaction of such a fine spot with a solid phase were studied. No noticeable widening of the ion beam due to space charge effect was observed. The use of the inactive intervals between two pulses of the electron beam for the regeneration of the emissive surface of the material was anticipated. (auth) (France)

45692 USE OF A CYCLOTRON WITH EXTERNAL SOURCES: POLARIZED PARTICLES AND HEAVY IONS. Beurtey, R.; Birien, P.; Durand, J. M.; Maillard, R.; Papineau, A.; Poussard, H.; Thirion, J. (CEN, Saclay, France). pp 559-61 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The diagram of the trochoidal injection system built at Saclay in the variable energy cyclotron for direct injection of the ionized particle beams is given. (auth) (France)

45693 PRODUCTION OF MULTIPLY CHARGED IONS WITH THE DUOPLASMATRON ION SOURCE. Ilgen, Joachim (Univ., Heidelberg). pp 563-9 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

Operating parameters of a duoplasmatron ion source for producing multiply charged ions are discussed including voltage division of the electrodes, magnetic field strength between intermediate electrode and anode, and arc voltage. (W.H.K.)

45694 ION SOURCE FOR MULTIPLY CHARGED HEAVY IONS. Bennett, J. R. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 571-85 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A description is given of the ion source used in the Harwell Variable Energy Cyclotron. Some of the characteristics of the source are indicated together with the results of laboratory tests and performance in the cyclotron. (auth)

45695 ION SOURCE OF THE ORSAY LINEAR ACCELERATOR FOR HEAVY IONS. Arianer, J.; Baixas, J.; Derbray, P.; Serafini, A.; Steinegger, A. (Institut de Physique Nucleaire, Orsay, France). pp 587-98 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A 1 MeV/nucleon beam is to be injected towards the center of the synchrocyclotron where it is to be stripped before any circular acceleration takes place. The unit consists in a linear accelerator preceded by an ion source. The source is of "reflex" type, with a cathode indirectly heated by electron bombardment from a filament. It must produce multicharged heavy ions with $Z_i/A \geq 0.09$, the ions covering the range from N to K. Owing to ion velocity at injector input the source must be insulated on a platform at 150 kV. The charge state and the emittance to be delivered by the source being well determined, an analyzer and focusing unit is associated with the source. (auth) (France)

45696 SOURCE OF HIGH-INTENSITY MULTICHARGED IONS. Knittner, G.; Maillard, R.; Papineau, A. (CEN, Saclay, France). pp 599-603 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A large cathode source for ionization of Li, C, N, O, Ne, by pulsed arc, is described. (auth) (France)

45697 LASER-MATTER INTERACTION INTENSE SOURCE OF MULTICHARGED IONS. Tonon, Gianfranco; Rabeau, Maxime (CEA, Villeneuve-Saint-Georges, France). pp 605-16 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970). (In French).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The laser–solid target interaction is shown to be a source of multicharged heavy ions. Measurements made on plasma show that it gets totally ionized and highly directive under strong illumination. This favors its possible use as a real ion source. The thermal model adapted to this type of interaction facilitates the possibility to reach high temperatures, which would allow to obtain, with Fe for instance, the ratio $\langle Z \rangle / A \sim 0.4$, with illumination already available in the laboratory. (auth) (France)

45698 ULTRAHIGH VACUUM ELECTRON BEAM SOURCE OF HIGHLY STRIPPED IONS. Donets, E. D.; Ilyushchenko, V. I.; Alpert, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 635-42 of Premiere Conference Internationale sur les Sources d'Ions, 18–20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

A technique of ionization and an experimental unit (EBIS) for highly stripped ion production by magnetic focusing of an electron beam are described. The beam obtained was analyzed with a mass spectrometer, the density of highly charged ions was

shown to increase with the time of confinement of the ion beam. This favours a process of multiple ionization involving the stripping of electrons one by one during a series of sequential collisions. The schemas of the ion source and of the time-of-flight analyzer for measurement of the ion charge spectrum are given. The basic difficulty of EBIS construction lies in the production of an electron beam of required density and length. The development of an electron beam ion source for a cyclotron is discussed. (France)

45699 HIPAC SOURCE OF HIGHLY STRIPPED HEAVY IONS. Daugherty, J. D.; Eninger, J. E.; Janes, G. S.; Levy, R. H. (Avco Everett Research Lab., Everett, Mass.). pp 643-54 of Premiere Conference Internationale sur les Sources d'Ions, 18-20 Juin 1969. Saclay, France; I. N. S. T. N. (1970).

From International Conference on Ion Sources, Saclay, France. See CONF-690625.

The general configuration and operating principles of the HIPAC source of highly-stripped heavy ions are described. Nominal parameters are presented for a representative source. Also, a brief review of the current state of experiments relating to the HIPAC ion source is given. (W.H.K.)

45700 POSSIBLE MECHANISM OF INCREASING THE BEAM EMITTANCE. Teplyakov, V. A. At. Energ. (USSR); 28: 508-9 (Jun 1970). (In Russian).

Measurements of the beam emittance on the linear accelerator at CERN have shown that the emittance does not remain constant. The radial motion of particles in a linear accelerator is described by a linear approximation with the solution being given by a matrix. Initially the particles lie within an ellipse. In the focusing period the distribution ellipse is determined by a matrix whose solution is presented. In the general case the matrix of the solution depends on three parameters during the focussing period. For various particles in the accelerated bundle the parameters of the radial motion are not the same, and do not remain constant. After n periods of focusing the behavior of two groups of particles is investigated, and an estimate is obtained for the emittance. The possible increase in beam emittance is greatest at the beginning of the acceleration where the amplitude of the particle phase oscillations is great. (TTT)

45701 LIMITING THE CURRENT IN LINEAR ACCELERATORS BECAUSE OF THE LONGITUDINAL FORCES OF THE SPACE CHARGE. Zhileiko, G. I.; Movsisyan, L. M. At. Energ. (USSR); 28: 511-13(Jun 1970). (In Russian).

The beam current of accelerated particles is limited by the repulsive effects between the charges of neighboring ions. The beam current is definitely related to the space-charge field. If the space-charge density and the region of capture are known, it is possible to determine the limiting current. This current is determined as the current corresponding to the maximum, possible, space-charge field. A number of expressions are derived for the limiting current. Three of the formulas give good approximations of the limiting current, and can be used for design calculations. These formulas are simpler than previous formulas published in the literature. (TTT)

45702 FORMATION SYSTEM AND BEAM PARAMETERS OF GAMMA QUANTA FROM A 2 GeV ELECTRON ACCELERATOR. Shramenko, B. I.; Tonapetyan, S. G.; Grishaev, I. A.; Goncharov, N. V.; Lapin, N. I.; Nikiforov, V. I.; Pugachev, G. D.; Khvorostyan, V. M. At. Energ. (USSR); 28: 509-11(Jun 1970). (In Russian).

The system of forming the gamma quanta consists of a electron collimator (copper) 600 mm long (41 X_0) with an internal diameter of 8 mm followed by a secondary emission monitor (with a coefficient K = 0.5 ÷ 0.025). Then the electron beam strikes a tantalum radiator 0.5 mm (0.13 X_0) thick which is followed by a deflecting magnet and photon collimators made of lead 500 mm long (96.5 X_0) with an internal diameter of 1 to 12 mm. The gamma beam passes through cleansing magnets having fields of 11,600 gauss in a gap of 80 mm, 11,100 gauss in a gap of 36 mm, and >16,000 gauss in a gap of 10 mm. The gamma-ray hardener consists of lithium hydride with a length of 2.8 X_0 or beryllium with a length of 3.0 X_0. The divergence of the photon beam after the second collimator with 1300 MeV electrons was 3.7×10^{-4} rads. The gamma-ray intensity on the target was 2.5×10^8 equivalent gamma quanta per sec with 1300 MeV electrons at an average current of 0.5 microamps (8 mm lead collimator). The system could be improved by varying the position and angles of the collimators by remote control. (TTT)

45703 INSTABILITY OF AN ELECTRON BEAM IN A SPACE-PERIODIC ELECTRIC FIELD. Aseev, G. G.; Kuznetsova, G. G.; Repalov, N. S.; Safronov, B. G.; Khizhnyak, N. A. At. Energ. (USSR); 28: 513-14(Jun 1970). (In Russian).

The passage of an electron beam through a longitudinal, electrostatic field may be accompanied by an instability in the longitudinal waves, if certain conditions are fulfilled. In case of a resonance at the main frequency (k = 1) there should take place a rapid increase in the field potential between non-moving electron bundles which may significantly exceed the external electrostatic field. A result of resonance at multiple frequencies is a strengthening in the initial level of the longitudinal oscillations of the beam. Experiments were carried out on a set of plates with a radius of 4.3 cm and a central opening of 1 cm. The beam radius r was 0.6 cm. The period of the system L was equal to 3.1 cm. The number of periods of the electric field was 10. The experiments showed that a spatially-periodic electric field under definite conditions leads to a strengthening of the initial level of high-frequency oscillations of the beam by more than two orders of magnitude. The amplitude of the oscillations as a function of the current, the accelerating potential of the beam and the magnitude of the electric field has a resonant character. The experimental values of the current and of the accelerating potential of the beam, which correspond to the maximum level of oscillations in the presence of an electric field, satisfactorily agree with calculations in the case of resonance at the second harmonic of the Langmuir beam frequency. (TTT)

45704 EXTREME ULTRAVIOLET SPECTROSCOPY WITH THE USE OF A STORAGE RING LIGHT SOURCE. Gaehwiller, Christian; Brown, Frederick C.; Fujita, Hiizu (Univ. of Illinois, Urbana). Rev. Sci. Instrum.; 41: 1275-81(Sep 1970).

The 240 MeV storage ring at the Physical Science Laboratory of the University of Wisconsin has been used as a source of radiation for extreme uv spectroscopy in the 40 to 400 Å wavelength range. The characteristics of the synchrotron radiation emitted by this machine are summarized. The experimental setup with a 2 m grazing spectrometer and the data acquisition system is described along with some of the procedures used for thin film photoabsorption measurements. (auth)

45705 HIGH CURRENT, SUBNANOSECOND RESPONSE FARADAY CUP. Pellinen, D. (Physics International Co., San Leandro, Calif.). Rev. Sci. Instrum.; 41: 1347-8(Sep 1970).

A subnanosecond risetime, milliohm resistance Faraday cup was designed and tested for measuring fractional megampere electron beams from pulsed electron accelerators. The device has been typically operated at electron beam currents of 60 kA with an average electron kinetic energy of 4 MeV. Under short circuit conditions the device has measured currents exceeding 0.25 MA. (auth)

45706 NEW METHOD FOR ACCELERATING NUCLEAR PARTICLES. Sarantsev, V. P. Priroda; No. 6, 30-7(Jun 1970). (In Russian).

A concept of cybernetic accelerator of superhigh energy of 1000 GeV is discussed. The scheme of interacting stationary and non-stationary charges, and the scheme of moving two-component rings in a collective accelerator are described as well as the scheme of potential well of the magnetic field and the variations of magnetic configurations. The general view of the accelerator model with its linear electron accelerator, chamber with circular cluster, and the scheme of the cluster accelerator are included. (R.V.J.)

45707 MINIMIZING PHASE LOSSES IN THE 680 MeV SYNCHROCYCLOTRON BY CORRECTING THE ACCELERATING VOLTAGE AMPLITUDE. Enchevich, I. B.; Tomilina, T. N. This paper was summarized in At. Energ. (USSR); 26: 285(Mar 1969) as paper No. 270. (In Russian).

A fall-off in the amplitude of the accelerating voltage at frequencies 18.5 and 15.5 MHz has been found to result in 10 to 15% reduced intensity due to phase losses. This amplitude fall-off may be due to excitation of oscillations in parasitic circuits brought about by the design of the RF system, or to beats caused by simultaneous satisfaction of self-excitation of both the main circuit and one of the parasitic circuits. A diagram of pulses with amplitude correction applied is shown. When the first correction pulse is delayed with respect to the commencement of the acceleration cycle by 2.0 msec ± 50 μsec, and with respect to the second correction pulse by 3.1 msec ± 50 μsec intensity becomes maximized. Correction pulse duration is arrived at experimentally and is found to be 140 ± 20 μsec for the first pulse, and 300 ± 20 μsec for the second correction pulse. The intensity rise resulting from the amplitude correction is roughly 12 to 18%. The current of the circulating proton beam is 2.1–2.3 μA when the correction circuit is not utilized. A calorimetric check run on the temperature of the coolant water revealed that the operation of the pulse-amplitude-corrected RF system of the accelerator does not bring about any appreciable increase in heating of specific units of the system, particularly in the case of supporting springs. (auth)

45708 POLARIZED PROTON TARGET FOR USE IN INTENSE ELECTRON AND PHOTON BEAMS. Borghini, M.; Chamberlain, O.; Fuzesy, R. Z.; (and others) (Univ. of California, Berkeley). Nucl. Instrum. Methods; 84: 168-72(1970).

Constructional details are given for the polarized butanol target which was developed for use at the Stanford Linear Accelerator. A sample preparation technique using ribbed plastic bags was used. The behavior under radiation damage is discussed. It was found to be possible to anneal out much of the radiation damage. Results obtained with a glycol target are also discussed. (auth)

45709 ISOTOPE SEPARATOR ON-LINE AT THE PRINCETON–PENNSYLVANIA ACCELERATOR. Spejewski, E. H.; Naumann, R. A.; Loeser, F. W. Jr.; Huebel, H.; Hopke, P. K. (Princeton Univ., N. J.). Nucl. Instrum. Methods; 84: 237-43 (1970).

An isotope separator placed on-line at the 3-GeV Princeton-Pennsylvania synchrotron for the study of short-lived nuclides produced by spallation is described. Initial experiences with a target of molten lead are presented. (auth)

45710 40 keV PULSED ELECTRON ACCELERATOR. Alberigi Quaranta, A.; Canali, C.; Ottaviani, G. (Univ., Modena, Italy). Rev. Sci. Instrum.; 41: 1205-13(Aug 1970).

A pulsed electron accelerator has been built with the following characteristics: energy of the electrons up to 40 keV; average current up to 20 μA; minimum duration of each burst about 70 psec; frequency of repetition of the bursts up to 10^4 Hz; jitter of the burst with respect to a trigger pulse less than 80 psec; number of electrons per burst (current 5 μA, duration 0.2 nsec) 6.3×10^3; typical fluctuation on the number of electrons contained in a burst (FWHM) 1%. The accelerator consists of an electron source, made with an electron gun of type commonly used in video tubes, and two pairs of deflection plates perpendicular to each other. The electron beam passes through the plates and the duration of each burst is controlled by a sine wave applied to a pair of plates, while the repetition frequency is controlled by pulses of suitable width and amplitude on the other pair of plates. A pretrigger pulse is available. This accelerator was built to create, in a very short time, a large number of electron-hole pairs ($\sim 8 \times 10^7$ in silicon) within a short distance of the surface of a semiconductor sample. As an application of this technique we describe briefly the measurement of the charge carriers' drift velocity in totally depleted silicon surface barrier junctions under pulsed bias conditions. Other applications are suggested. (auth)

45711 HIGH RESOLUTION WIDE RANGE PHOTON TAGGING SYSTEM. Brookes, G. R.; Hinds, S.; Rawlinson, W. R.; Rousseau, M. D.; Tolfree, D. W. L.; Wardle, A. G. (Daresbury Nuclear Physics Lab., Warrington, Eng.). Nucl. Instrum. Methods; 85: 125-31(1 Aug 1970).

A photon tagging array which measures the energy of photons in a bremsstrahlung spectrum is described. The apparatus covers an energy range of 1600 MeV starting 250 MeV below the energy of the incident electron beam. Sixty-four tagged channels provide a theoretical resolution of ±12.5 MeV and measurements indicate the overall resolution, using a 1/100 radiation length radiator, to be better than ±17.5 MeV. Design and constructional features are incorporated which permit considerable reductions in the installation, survey and monitoring requirements. (auth)

45712 MEDIUM SIZE POLARIZED PROTON TARGET. Burget, J.; Odehnal, M.; Petricek, V.; Sacha, J.; Tichy, R. (Nuclear Research Inst., Rez, Czech.). Nucl. Instrum. Methods; 85: 81-4(1 Aug 1970).

A medium size polarized proton target is described. Dimensions of the target crystal of lanthanum magnesium nitrate are $10 \times 10 \times 0.75$ mm^3. The target crystal is located in vacuum and cooled indirectly. In a field of 18 kG and at temperature of 1.20°K proton polarization ±50% is obtained. (auth)

45713 POLARIMETER FOR USE IN GENERAL PURPOSE SCATTERING CHAMBERS. Bond, C. D.; McGarry, W. I.; August, L. S.; Shapiro, P. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 85: 85-91(1 Aug 1970).

A relatively simple double scattering apparatus designed to operate within a general purpose 30-inch scattering chamber is described. The system can be used to make polarization measurements over a wide range of energies and ion species. System details, method of measurements and initial operating results are discussed. (auth)

45714 SHIELDING TESTS AT THE 10-GeV PROTON SYNCHROTRON NEUTRON BEAM. Aleinikov, B. E.; Zaitsev, L. N.; Komochkov, M. M.; Lebedev, V. N.; Mal'kov, V. V.; Nenast'ev, M. V.; Salatskaya, M. I.; Sychev, B. S. This paper was summarized in At. Energ. (USSR); 26: 541(Jun 1969) as paper No. 311. (In Russian).

The results are presented of particle flux measurements in a concrete shield exposed to a beam of neutrons with an average energy of 6.6 GeV. The radiation was recorded with activated indium and carbon detectors, and with 600 μ thick layers of NIKFI-R emulsion. A comparison of the measured data with calculated data shows that the configuration of the experiment may be regarded as an intermediate case of radiation attenuation in the shield, which lies between the extremes of an undirectional point source and an undirectional flat source. (L.B.S.)

45715 USE OF ION ACCELERATORS FOR ACTIVATION ANALYSIS. Salamon, Andras; Szabo, Elek (Research Inst. for Applied Physics, Budapest. Central Research Inst. for Physics, Budapest). Kem. Kozlem.; 33: 179-98(1970). (In Hungarian).

The advantages, shortcomings and potential of application of ion accelerators for activation analysis are examined, considering specifically their use in Hungary where there is a shortage of suitable equipment. The basic concepts, such as the properties of accelerated ion beams, the threshold energy, ion flux and cross section values, are considered individually. In order to obtain maximum sensitivity, the accelerator should be able to yield sharp, well focused beams with an energy that may be varied up to 50 MeV; it is also desirable to cool the sample because the method must be limited otherwise to materials with a melting point higher than 300°C. The reaction products are usually β-active isotopes which may be conveniently determined by means of multichannel amplitude analyzers. The few products exhibiting measurable γ activity may be measured with an attached scintillation system or semiconductor detectors. For prompt neutrons, BF_3 counters or time-of-flight techniques are used. A 5 MeV Van de Graaff accelerator will become available at the Central Research Institute for Physics for this purpose. The Institute's present accelerator may be used to accelerate deuterons and protons. Studies have started to determine C, O, B and Si. Charged-particles experiments will be carried out with the research reactor. New equipment is expected from the Soviet Union and East Germany for determining impurities in high-purity materials. (110 references). (TTT)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 44276, 45300, 45994, 46011, and 46017.

45716 (BNL-50205, pp 26-32) NATIONAL NEUTRON CROSS SECTION CENTER. Pearlstein, S. (Brookhaven National Lab., Upton, N. Y.).

The activities of the National Neutron Cross Section Center are described. Compilation and evaluation activities, computer applications, and development of cross section theory are discussed briefly. (J.W.R.)

45717 (RT/FIMA-(69)2) COMPARISON BETWEEN SEVERAL STATIONARY MULTIGROUP DIFFUSION CODES. Bittoni, E.; Giambuzzi, S. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). [1969]. 36p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The PDQ-2, ALCI-1, EXTERMINATOR, CRAM, and SQUID 2 II codes for the solution of neutron diffusion equations are compared. The results obtained with each code for the value K_{eff} are reported. These results are compared and show that with two exceptions the relative percentage variation in 20 problems is a maximum of a few percent. The execution time for each of the codes is also considered. (J.S.R.)

45718 METHOD FOR PRODUCING OUTGASSED PERMANENT MAGNETS AND NEUTRON GENERATOR TUBE INCORPORATING SUCH A MAGNET. (to Schlumberger Technology Corp.). British Patent 1,189,911. 29 Apr 1970. Priority date 13 Feb 1967, United States.

An outgassed permanent magnet was produced by heating a permanently magnetizable material to a temperature above 400°C, reducing the pressure of the emanating gas to 10^{-5} mm Hg, allowing the material to cool, and then subjecting it to a magnetic field to permanently magnetize the material. Permanent magnets produced by this method are suitable for use in neutron generator tubes. A neutron generator tube using such a magnet to produce a magnetic flux density of 400 G is described. (B.L.M.)

45719 IMPROVEMENTS RELATING TO NEUTRON GENERATION. (to Kaman Corp.). British Patent 1,190,991. 6 May 1970. Filed 16 May 1967.

Neutron generating apparatus is described which comprises an elongated cylindrical envelope forming a sealed evacuated chamber containing an ion source, with a target axially spaced from the source. The target includes a substance which reacts to produce neutrons. Means are selectively operative to release an isotope of hydrogen within the chamber, the deuterium or tritium acting as ionization medium. The target is earth connected and a source of alternating potential is connected between the ion source and the target so as to make the ion source alternatively positive and negative with respect to the target and to accelerate ions into neutron producing collisions with the target material. Means may be included to suppress secondary electron emission from the target, and a control electrode may be positioned in the path of ion travel and energisable to control the path. The means to selectively release an isotope of hydrogen within the chamber may comprise a reservoir including a substance loaded with this isotope and operative to release the isotope into the chamber when heated. Various alternative methods of operating the apparatus are described. (UK)

45720 RETHERMALIZATION IN GRAPHITE. Stefan, H.; Girlea, I.; Cristian, I.; Fodor, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 329-38(1970).

The graphite rethermalization cross section was determined by two methods: the total thermal neutron flux spatial variation and the effective temperature spatial variation. The temperature range was 20 to 450°C. The temperature dependence of the spectral indexes (Lu/Dy) and (Eu/Dy) was determined, both theoretically and experimentally. The results obtained by the two above methods are in disagreement, both as to values and form of the temperature dependence. A brief review of the causes of this discrepancy is given. (auth)

45721 NUMERICAL SOLUTION OF THE SPACE- AND TIME-DEPENDENT NEUTRON-DIFFUSION EQUATIONS. Rhyne, William Rutledge. Charlottesville, Va.; Univ. of Virginia (1969). 139p.

Thesis.

A new technique was developed for the numerical solution of the space- and time-dependent neutron diffusion equations. This technique permits a significant reduction in the computer time required to solve these equations, by substantially increasing the allowable time step size and, to a lesser degree, by simplification of the calculations. The time-dependent group diffusion equations are transformed into the Laplace domain and after appropriate manipulation are then transformed back into the time domain. The resulting equations appear as a set of coupled convolution integrals. This set of equations is then solved using a conventional numerical method; however, very large time steps are possible. The technique was first applied to the transient analysis of the point reactor and compared with experimental results and with other numerical methods. The computer solution time was a factor of from five to thirty less than that of existing methods. Secondly, the technique was applied to the multi-dimensional, multi-energy group, time-dependent diffusion equations. Comparisons to other numerical solutions were made for the one-dimensional, two-energy group case. The allowable time step size was found to be generally an order of magnitude larger than with existing methods, thus permitting, typically, a factor of ten reduction in computer solution time. (Diss. Abstr. Int., B)

45722 SPIN-DEPENDENT SCATTERING OF THERMAL NEUTRONS FROM POLARIZED NUCLEI IN MAGNETICALLY ORDERED SOLIDS. Markworth, Alan John. Columbus, Ohio; Ohio State Univ. (1969). 131p. University Microfilms Order No. 70-6828.

Thesis.

An analytical study is presented of the spin-dependent scattering of thermal neutrons from magnetically ordered solids at temperatures sufficiently low that polarization of atomic nuclei is induced. Polarization is assumed to occur through the magnetic hyperfine interaction between a nucleus and its atomic electrons. Neutrons are scattered both by atomic nuclei (spatially isotropic scattering) and the unpaired atomic electrons (anisotropic "magnetic" scattering). Two analytical approaches are followed, leading to consistent results. In the first, the polarization-dependent probabilities that a coupled neutron–nucleus spin system be in a given total spin state (characterized by a given scattering amplitude) are calculated. These probabilities are then used to evaluate the coherent scattering cross section characteristic of certain Bragg reflections for hypothetical antiferromagnetic and ferromagnetic crystals. In the second approach, the Born approximation is used to calculate the spin-dependent scattering cross section for a more generalized magnetic crystal. A pseudopotential based on nuclear and magnetic scattering from the component atoms of the crystal is used in this calculation. The general expression thus derived for the cross section is then applied to the specific crystalline systems studied under the first approach and the results are found to be consistent. Methods for implementing these results experimentally are also discussed. For example, it is shown how nuclear-polarization-dependent variations in the coherent scattering can be used to resolve a mathematical ambiguity associated with the spin-dependent scattering amplitudes. This experiment can be expediently performed with an antiferromagnetic crystal and unpolarized neutrons. An analysis is also presented, and experimental applications discussed, of the coherent spin-dependent scattering from a "polarizer-analyzer" system in which both the polarizer and analyzer are ferromagnetic crystals, with the atomic nuclei of the polarizer assumed to be polarized. It is shown that under certain conditions, the intensity of neutrons coherently scattered from both polarizer and analyzer depends critically upon the square of the nuclear polarization and varies, at low temperatures, only slightly about a "high-temperature" null value. Values of the polarization of the coherently scattered neutron beam are calculated for the various regions of the polarizer-analyzer system. As a pedagogical application of spin-dependent scattering, the "Bragg law" and neutron polarization for both nuclear and magnetic scattering from a hypothetical, one-dimensional, helical spin system are evaluated. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 44305, 45418, 45454, 45817, and 45818.

45723 THE RESONANCE AT $E_d \simeq 100$ keV IN THE $^2H(d,p)^3H$ AND $^2H(d,n)^3He$ REACTIONS. Fick, D.; Franz, H. W. (Univ., Erlangen-Nuernberg, Erlangen, Ger.). pp 221-2 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45724 INVESTIGATION OF EXCITED STATES OF THE α-PARTICLE BY COINCIDENCE MEASUREMENTS. Haase, E. L.; Hagelberg, R.; Wang, W. N.; Fawzi, M. A.; Siebert, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 223-6 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45725 ELASTIC ELECTRON SCATTERING FROM ^{4}He. Vinciguerra, D.; Stovall, T. (Ecole Normale Superieure, Orsay, France). pp 248-9 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45726 ACCURATE UPPER AND LOWER BOUNDS FOR THE BINDING ENERGY OF ^{3}H WITH SOFT-CORE POTENTIAL. Ziegelmann, H. (Univ., Tuebingen, Ger.). pp 287-8 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45727 REACTIONS IN THE ^{5}He SYSTEM. Heiss, P.; Hackenbroich, H. H. (Univ., Cologne). pp 311-12 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45728 DISTORTION EFFECTS IN ELASTIC α-d SCATTERING. Jacobs, H.; Wurster, Eva J. (Univ., Tuebingen, Ger.). pp 313-14 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45729 THREE-BODY PHOTODISINTEGRATION OF ^{3}He. Berman, B. L.; Fultz, S. C.; Yergin, P. F. (Univ. of California, Livermore). Phys. Rev. Lett.; 24: 1494-6(29 Jun 1970).

The photoneutron cross section for ^{3}He was measured with monenergetic photons from threshold to 30 MeV. The cross section rises to a maximum value of 0.95 mb at 15 MeV; the integrated cross section is 13.0 MeV-mb. Some structure is evident. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 44305, 45272, 45770, 45804, 45817, and 45820.

45730 (INR-P-1179) $\alpha-\alpha$ INTERACTION IN THE $^3_\Lambda$Be $\rightarrow \alpha + \alpha + p + \pi^-$ DECAY. Chlebowska, D.; Wrzecionko, J.; Zielinska-Pfabe, M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 7p. Dep. CFSTI (U.S. Sales Only).

The α-particle energy distribution is calculated for the $^3_\Lambda$Be $\rightarrow \alpha + \alpha + p + \pi^-$ decay. The $\alpha-\alpha$ final-state interaction described by the Gaussian and Coulomb potential is treated exactly. The narrow peak at 0.095 MeV, which clearly corresponds to the 0^+ ground state of ^{8}Be, was obtained. (auth)

45731 (NP-18301) POLARIZATION MEASUREMENT WITH DOUBLY ELASTICALLY SCATTERED DEUTERONS ON ^{12}C FOR ENERGIES BETWEEN 41 AND 51 MeV. Seibt, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jan 1970. 127p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Karlsruhe, Ger.

Polarization measurements with deuterons on ^{12}C between 41 and 51 MeV were carried out at the Karlsruhe isochronocyclotron using a double scattering device. This previously unstudied energy range is especially suitable for the study of the spin-dependent interaction terms in the optical potential. As a result of the small tensor polarization effects the energy and angular dependences of the vector polarization iT_{11} were determined with the help of a calibration experiment, scattering on ^{12}C of unpolarized deuterons. The deuteron vector polarization shows an exceptionally strong angular dependence, but strong energy dependence was observed only at a scattering angle of 58°. The maximum value found for the deuteron vector polarization was iT_{11} (51 MeV, 58°) = +0.453 ± 0.048. This value corresponds to a polarization degree of 52% of the maximum value consistant with pure vector polarization. Under these conditions ^{12}C is a good analyzer for the deuteron vector polarization with an extrapolated effective cross section of about 40 mb/sr. For testing of the double scattering apparatus on apparative asymmetries, zero experiments with 100 MeV α particles were carried out at the primary angles 23°, 24.5°, and 30°. The results were $A_0 = +0.006 \pm 0.002$ and $B_0 = -0.005 \equiv 0.003$. The supplementary evaluation of the over-under asymmetry distribution describing Sine Φ terms gives a value, averaged over all measurements, of $C = -(0.084 \pm 0.165)\%$. These results show that the systematic errors are very small. The comparison of the measurement curves with the theoretical calculations of an optical model analysis by Satchler shows only qualitative agreement. For adaptation of the otical model paraters the elastic scattering cross section data of ^{12}C were used. For the spin-orbit-potential a mean value of $V_s = 6.7 \pm 0.8$ MeV was obtained. The uncertainty given contains statistical errors, uncertainty in the radial dependence of the LS terms, and uncertainty for the tensor component T_{2k}. (tr-auth)

45732 EXCITED STATES IN ^{19}F. Sellin, David Lee. Durham, N. C.; Duke Univ. (1969). 94p.

Thesis.

The ^{18}O(p,p)^{18}O and ^{18}O(p,α)^{15}N excitation functions were investigated in the energy range E_p = 1.39 to 3.20 MeV by simultaneous observation of protons and α-particles at 135°. Only twelve prominent elastic scattering levels were observed at this angle and at 45°, despite the high experimental resolution (less than 400 eV energy spread). R-matrix expressions for multichannel multilevel cross sections were programmed and used to analyze these data. Three of the resonances were determined to be s-wave and seven d-wave, while only two were found to have odd parity. Spins were assigned to each of these twelve resonances except for one d-wave. The experimental results were compared with those of a shell model calculation. This model predicts positive parity doorway states in the energy range of the experiment. These states are formed from a 2p-1h model treating the target ^{18}O as the core. It is assumed that these doorway states fragment via couplings with more complex configurations. In this way, each positive parity level observed in the present experiment can be associated with a doorway state. In particular, both the data and the model indicate that the $5/2^+$ level observed at 2.768 MeV may be identified as the analogue of the 3.16 MeV level in ^{19}O; however, isobaric spin impurities are present. No similar fragmentation was observed for the proton interaction with ^{16}O under the same condition. (Diss. Abstr. Int., B)

45733 INELASTIC ELECTRON SCATTERING. Hansteen, J. M. (Univ. of Bergen). pp 45-57 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The application of inelastic electron scattering as a tool for exploring cluster effects in light nuclei is discussed. The inelastic scattering on ^{6}Li is discussed in detail, with brief mention of scattering on ^{7}Li and ^{9}Be. (L.W.A.)

45734 THE ^{9}Be(p,pα)^{5}He AND ^{12}C(p,pα)^{8}Be REACTIONS AT 57 MeV. Ludemann, C. A. (Oak Ridge National Lab., Tenn.); Goodman, C. D.; Roos, P. G.; Pugh, H. G.; Holmgren, H. D.; Epstein, M. B.; Jain, M.; Wall, N. S. pp 213-15 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45735 THE ^{12}C(p,α)^{9}B REACTION WITH 14 TO 17 MeV PROTONS. Koenig, H. G.; Staudt, G. (Univ., Tuebingen, Ger.). pp 216-18 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45736 (^{3}He,t) REACTIONS ON ^{6}Li AND ^{7}Li. Nuesslin, F. (Max Planck Inst. for Nuclear Physics, Heidelberg); Werner, H.; Zimmerer, J. pp 229-31 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45737 ^{11}B(p,α)^{8}Be(α)^{4}He REACTION WITH E_p < 1400 keV. Treado, P. A.; Lambert, J. M.; Alessi, V. E.; Kane, R. J.

(Georgetown Univ., Washington, D. C.). pp 232-6 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45738 CLUSTER STRUCTURE OF ^{6}Li FROM ELASTIC ELECTRON SCATTERING AND π^--MESON ABSORPTION. Alberi, G. (Inst. of Theoretical Physics, Trieste, Italy); Cheon, Il-T.; Ciofi degli Atti, C. pp 239-41 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45739 IS ^{6}Li(γ,T)^{3}He A DIRECT REACTION? Clement. D.; Wittern, H. W. (Univ., Tuebingen, Ger.). pp 244-5 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45740 INFLUENCE OF ANTISYMMETRIZATION ON SOME REDUCED MATRIX ELEMENTS OF ^{6}Li. Belschner, D.; Wittern, H. W. (Univ., Tuebingen, Ger.). pp 250-1 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45741 CLUSTERS IN CARBON, NITROGEN, AND OXYGEN NUCLEI WITH STOPPING K^- PROBES. Kurtz, Nicole; Braun, H.; Cueer, P. (Centre de Recherches Nucleaires, Strasbourg). pp 257 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45742 ABSORPTION OF π-MESONS IN THE LIGHT NUCLEI CARBON, NITROGEN, AND OXYGEN. Massue, J. P. (Centre de Recherches Nucleaires, Strasbourg); Auslander, J.; Cueer, P.; Sidorov, V. M.; Yarba, V. A.; Bugnatov, S. A.; Batusov, A. pp 258-60 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45743 SOME MECHANISMS AND PARTIAL RESONANCES IN THE REACTIONS $\alpha + {}^{12}C \rightarrow 4\alpha$ AT 90 MeV. Jacquot, C.; Jung, M.; Baixeras-Aiguabella, C.; Braun, H.; Schmitt, R.; Cueer, P. (Univ., Strasbourg). pp 262-5 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45744 THE ALPHA-PARTICLE CHAIN-LIKE SOLUTION OF THE HARTREE-FOCK EQUATION. Ikeda, K. (Univ. of Copenhagen). pp 277-80 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45745 ALPHA CLUSTER STRUCTURE IN ^{12}C. Yamashita, J.; Abe, Y.; Hiura, J.; Tanaka, H. (Hokkaido Univ., Sapporo). pp 281-3 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45746 THREE-BODY FORCES AND THE BINDING ENERGY OF LIGHT NUCLEI. Nash, G. F. (The University, Southampton, Eng.). pp 294-5 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45747 REFINED CLUSTER MODEL CALCULATIONS FOR ^{6}Li LEVELS. Hackenbroich, H. H. (Univ., Cologne); Wodsak, W. W. pp 296-7 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45748 DECAY OF ^{12}C* INTO THREE ALPHA PARTICLES. Schaefer, K. (Univ., Heidelberg). pp 315-16 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45749 ESTIMATE OF THE α-CLUSTER STRUCTURE OF ^{12}C VIA THE ^{12}C(d,p)^{13}C STRIPPING REACTION. El-Nadi, M.; Zohni, O. (Cairo Univ.). pp 318-20 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45750 ANALYSIS OF THE 3 α-DECAY OF ^{12}C USING THREE-BODY PARTIAL WAVES. Sauerland, T. (Ruhr Univ., Bochum, Ger.). pp 329-31 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45751 STRIPPING REACTIONS ON NUCLEI OF THE 1p SHELL INITIATED BY VECTOR-POLARIZED DEUTERONS. Fick, D.; Kankowsky, R.; Kilian, K.; Salzborn, E. (Univ. Erlangen-Nuernberg, Erlangen, Ger.). Phys. Rev. Lett.; 24: 1503-6(29 Jun 1970).

Stripping reactions on target nuclei with spin generally involve at least two values of the angular-momentum transfer j of the captured nucleon. The probabilities p_j for transfer of a neutron with total angular momentum j were determined using vector-polarized deuterons to initiate a number of (d,p) reactions with l = 1 on ^{6}Li, ^{9}Be, ^{10}B, ^{11}B, and ^{14}N. The results exhibit in general a rather good agreement with shell-model calculations by Cohen and Kurath. (auth)

45752 STUDY OF THE MECHANISM OF THE (α,2α) REACTION ON ^{6}Li. Gaillard, P. (Univ., Lyon); Chevallier, M.; Grossiord, J. Y.; Guichard, A.; Gusakow, M.; Pizzi, J.-R.; Miallard, J.-P. Phys. Rev. Lett.; 25: 593-6(31 Aug 1970).

The (α,2α) reaction on ^{6}Li has been studied at an incident energy of 42.8 MeV. At this energy, a sharp resonance in the free α-α scattering cross section is used to test the validity of the impulse approximation. The experimental results are analyzed with this model. (auth)

45753 POLARIZATION OF PROTONS IN ^{12}C(d,p)^{13}C REACTION. Bondouk, I. I.; Machali, F.; Saleh, Z. A. (Atomic Energy Establishment, Cairo). Z. Phys.; 236: 170-5(1970).

The angular distributions of the polarization of protons from ^{12}C(d,p)^{13}C(g.s) reaction were measured at 200-keV intervals for deuteron energies from 1.40 to 2.40 MeV. Elastic scattering on ^{12}C at 45° (lab) was used to analyze the polarization. Positive sign of the polarization corresponds to the vector product $K_d \times K_p$. The maximum polarization observed is about 30%. The results are not similar to those obtained from the mirror reaction ^{12}C(d,n)^{13}N in the same deuteron energy range. (auth)

45754 ^{6}Li(^{3}He,d)^{7}Be REACTION AT LOW ENERGIES. Aleksic, M. R.; Popic, R. V.; Stanojevic, D. M.; Stepancic, B. Z. (Boris Kidric Inst. of Nuclear Science, Belgrade). Fizika (Zagreb); 2: 113-19(1970).

The reactions ^{6}Li(^{3}He,d_0)^{7}Be$_{g.s}$ and ^{6}Li(^{3}He,d_1)^{7}Be$_{431}$ have been investigated for ^{3}He energy interval from 0.5 to 1.3 MeV by measuring the ^{7}Be 431 keV and ^{7}Li 478 keV gamma rays resulting from the decay of ^{7}Be. The excitation curves for both reactions were obtained. Their analysis shows the presence of a $\frac{1}{2}^+$ or $\frac{3}{2}^+$ state (T = ½) in ^{9}B at 17.20 ± 0.02 MeV, with Γ = 110 ± 30 keV, and of a direct mechanism contribution indicating that wave function extranuclear contribution is dominant in the region just above the reaction threshold. (auth)

45755 ASSIGNMENT OF $J^\pi = \frac{3}{2}^-$ FOR THE 8.11-MeV LEVEL OF ^{11}C. Fortune, H. T.; Comfort, J. R.; Maher, J. V.; Zeidman, B. (Argonne National Lab., Ill.). Phys. Rev., C; 2: 425-9(Aug 1970).

A study of the ^{10}B(^{3}He,d)^{11}C and ^{12}C(^{3}He,α)^{11}C reactions leading to the 8.11-MeV state in ^{11}C yields an unambiguous assignment of $J^\pi = \frac{3}{2}^-$ for that state. (auth)

45756 DWBA KNOCKOUT ANALYSIS OF ^{19}F(α,t)^{20}Ne REACTION AT 18.5 AND 28.5 MeV. Polson, William Jerry. Auburn, Ala.; Auburn Univ. (1969). 98p.

Thesis.

A distorted wave Born approximation knock-out analysis of the ^{19}F(α,t)^{20}Ne reaction at incident alpha energies of 18.5 MeV and 28.5 MeV is presented. The target and residual nuclei are as-

sumed to possess a cluster model structure, and optical model distorted wave functions are used to describe the incident particle which is assumed to be scattered by the nuclear core cluster. The mass of the nuclear core is taken to be both finite and infinite relative to the incident and bound particles in the calculations, and both deep and shallow optical model potential wells are used in the computation of the distorted waves. Numerical calculation of the ground and first excited state angular distributions at both incident alpha energies indicates that these reactions proceed predominantly via a knock-out mechanism, that the deep optical potential wells are more suitable for DWBA calculations than are shallow optical potential wells, and that the choice of bound state wave function parameters is critical to the success or failure of any DWBA theory. (Diss. Abstr. Int., B)

45757 YIELDS OF ^{11}C, ^{13}N, AND ^{18}F ON IRRADIATING NITROGEN WITH PROTONS, DEUTERONS, ^{3}He IONS, AND ALPHA PARTICLES. Krasnov, N. N.; Dmitriev, P. P.; Dmitrieva, Z. P.; Konstantinov, I. O.; Molin, G. A. At. Energ. (USSR); 28: 503-4(Jun 1970). (In Russian).

The yields of the above short-lived radioactivities were measured as a function of the energy of the bombarding particles. The particle energy was varied by means of a retarding foil. The error in the yield determination was ±10%. Theoretically all four types of particles may be used to detect nitrogen by activation analysis. However it is most convenient to use proton irradiation since the highest yield is obtained from the N-14 (p,α) C-11 reaction, especially at low proton energies. The yields are expressed in disintegrations of C-11, N-13 or F-18 per second per microampere-hour. The F-18 activity is formed selectively by bombarding nitrogen with alpha particles having an energy less than 22 MeV. (TTT)

45758 STUDY OF THE ISOSPIN FORBIDDEN $^{14}N(\alpha,\alpha_1)^{14}N^*$ REACTION. Tollefsrud, Philip Bjorn. Madison, Wis.; Univ. of Wisconsin (1969). 102p.

Thesis.

Differential cross sections for $^{14}N(\alpha,\alpha_1)^{14}N^*$ were measured. The alpha beam was supplied by injecting He^- from an improved ion source into a tandem accelerator. The reaction occurred in a new multi-detector differentially pumped gas scattering chamber. Solid state detectors were used for detection of reaction products. Excitation functions in 30 keV alpha energy steps were made at eight angles from 12.750 MeV $\leq E_\alpha \leq$ 18.240 MeV and at 15 angles from 10.320 MeV $\leq E_\alpha \leq$ 12.720 MeV. The cross sections exhibit strongly resonant behavior indicative of compound nucleus formation. No evidence supporting the presence of direct or semidirect reaction mechanisms was found. The cross sections were expanded in partial waves. Partial waves up to l = 6 were necessary to get satisfactory fits to the data. This expansion uniquely determines the J^π of a single resonant state of ^{18}F. Cross section measurements were also made on the reaction leaving ^{14}N in its ground and second excited state. These data were not subjected to analysis however, except for fitting the inelastic groups to a Legendre polynomial expansion. This expansion permits the comparison of the total cross sections for the first two inelastic groups, and therefore provides a basis for estimating the amount of isospin impurity in ^{18}F. At individual resonances the impurities are as much as 25% with average impurities ~5%. The data presented here confirms and extends information on isospin impurities of ^{18}F levels reported earlier. (Diss. Abstr. Int., B)

45759 ANGULAR DISTRIBUTION OF THE NEUTRON POLARIZATION FROM $^{11}B(\alpha,n)^{14}N$ REACTION AT LOW ENERGY. Ciocanel, A.; Molea, M.; Pencea, C.; Salagean, O. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 563-7(1970).

The measurement of the neutron polarization from the $^{11}B(\alpha,n)$ ^{14}N reaction at 3.6 and 3.8 MeV was done to investigate the reaction mechanism and the level structure of the compound nucleus ^{15}N. Time-of-flight standard technique with improved radiation shielding and proper resolution was used. The preliminary analysis of the experimental data indicates the formation of the compound nucleus ^{15}N with the participation of the 13.63 $(5/2, 7/2)^-$, 13.70 (?) and 13.79 $(5/2)^+$ excited levels in ^{15}N. Subsequent calculation will make clear if the magnitude of the polarization is determined by the interference of these levels only, or if it will be necessary to take into account a ground term of the R-matrix, as well as a direct contribution, which is slowly changing with incident energy. (auth)

45760 ELASTIC SCATTERING: ^{14}N–^{14}N AND ^{14}N–^{16}O. Jacobson, Larry Alan. Madison, Wis.; Univ. of Wisconsin (1969). 92p.

Thesis.

A description is given of a direct-extraction duoplasmatron ion source based on a design developed at Los Alamos. Besides good beam quality and simplicity of operation, plentiful heavy-ion beams are a feature of this source. Using the NH_2^- beam produced by the ion source, the elastic scattering processes ^{14}N–^{14}N and ^{14}N–^{16}O were studied. A position-sensitive detector and a differentially pumped gas scattering chamber were used to obtain 40-50 point angular distributions spanning ~35°–115° (CMS) in steps of 100 keV (CMS) from 5–18 MeV for ^{14}N–^{14}N and 8–18.5 MeV (CMS) for ^{14}N–^{16}O scattering. The ^{14}N–^{14}N scattering was also investigated from 18–20 MeV (CMS) in .5 MeV steps. The excitation function at selected angles for the ^{14}N–^{14}N scattering shows little structure at any energy except for two broad but attenuated peaks in the 90° excitation function between 13–20 MeV. The ^{14}N–^{16}O excitation functions show no structure below 13 MeV but do show broad structure and possibly some fine structure at several angles to higher energy. These data were analyzed using an optical model employing a Wood-Saxon potential and a modified diffraction model. Except at low energies, neither model produced adequate fits at all angles. Better fits will probably not be achieved without the inclusion of some sort of hard core at short range. (Diss. Abstr. Int., B)

45761 GAMMA-RAY SCATTERING EXPERIMENT. Sugawara, Masumi; Saito, Teijiro; Itoh, Kohei; Nakada, Akira (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 1: No. 1, 18-19(1968). (In Japanese).

The preliminary experiment of gamma-ray scattering with bremsstrahlung of electrons is reported. Experimental apparatus was shielded with heavy concrete, water, boron, paraffin and lead shield in order to reduce neutron background generated from a bremsstrahlung target and an electron beam catcher. A 4″ ϕ × 4″ NaI(Tl) scintillation counter was used to measure the gamma-ray spectrum at the solid angle of 0.15 steradian. A 3.0 g/cm² thick carbon target was used for the gamma-ray scatterer. The resonance scattering by the 15.1 MeV excited state of ^{12}C, the cross section of which is about 2 mb-MeV, was observed. The maximum energy of the bremsstrahlung was 20 MeV. The result shows that the gamma-ray scattering experiment having a cross section of around 0.2 mb-MeV is possible with the present arrangement of the apparatus. The scattering cross section of the giant resonance is 0.2 mb-MeV or more except that for light nuclei, therefore it is measurable. (auth)

45762 EXCITATION OF 3,56-MeV LEVEL OF ^{6}Li BY ELECTRON SCATTERING. CALCULATION IN THE FRAMEWORK OF THE GENERALIZED HARTREE–FOCK THEORY. Van Leuven, P.; Wagemans, C. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). J. Phys. (Paris); 31: 149-50(Feb-Mar 1970). (In French).

The transverse form factor for the excitation of the 3.56-MeV level in ^{6}Li is calculated and compared with two groups of experimental data. The disagreement between theory and experiment is traced back to the method of measurement analysis. (auth) (France)

45763 SELECTIVE POPULATION OF HIGHLY EXCITED STATES OBSERVED IN THE REACTION $^{16}O(^{12}C,\alpha)^{24}Mg$. Middleton, R.; Garrett, J. D.; Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 24: 1436-8(22 Jun 1970).

The reaction $^{16}O(^{12}C,\alpha)^{24}Mg$ was observed to populate states at E_x = 16.30, 16.55, and 16.84 MeV with center-of-mass cross sections (at Θ_{cm} = 11°) of 1.8, 4.5, and 4.1 mb/sr, respectively. The evidence suggests that these states possess high angular momentum. Another state observed at E_x = 15.15 MeV could be the J^π = 9^+ member of the K = 2 rotational band. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 43934, 44059, 44305, 45763, and 45821.

45764 (ORNL-tr-2338) DECAY OF ^{59}Fe AND EXCITED LEVELS OF ^{59}Co. Beraud, Robert; Berkes, Istvan; Daniere, Joannes; Levy, Michele; Marest, Gilbert; Rougny, Robert. Translated by Martha Gerrard and J. J. Pinajian (Oak Ridge National Lab., Tenn.), from Compt. Rend., Ser. B; 265: 1354-6(1967). 5p. Dep. CFSTI.

The energies and intensities of the transitions between the excited levels of ^{59}Co were determined with precision using a Ge(Li) detector. The half-life of the excited level at 1291.5 keV was measured by the delayed-coincidence method. A scheme for the decay of ^{59}Fe to ^{59}Co is proposed. (auth)

45765 THE PHOTONUCLEAR REACTIONS (γ,np) AND $(\gamma,2n)$ IN ^{46}Ti. Gayther, D. B. (Atomic Energy Research Establishment, Harwell, Eng.); McMillan, J. W.; Medicus, H. A. pp 246-7

of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45766 USE OF THE ALPHA PARTICLE MODEL FOR CALCULATING LOW EXCITED STATES IN 4N NUCLEI LIKE ^{20}Ne. Weiguny, A. (Univ., Freiburg i. B.). pp 284-5 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45767 ALPHA CLUSTER PLUS ^{16}O-CORE MODEL FOR ^{20}Ne AND NEIGHBOURING NUCLEI. Hiura, J. (Hokkaido Univ., Sapporo); Abe, Y.; Saito, S.; Endo, O. pp 299-302 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45768 OPTICAL-MODEL ANALYSIS OF 50- AND 64-MeV ALPHA-PARTICLE SCATTERING FROM ^{58}Ni AND ^{58}Fe. Weisser, David C.; Lilley, J. S.; Hobbie, Russell K.; Greenlees, G. W. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 2: 544-50 (Aug 1970).

An optical-model analysis of the scattering of 64.3-MeV α particles from ^{58}Ni and ^{58}Fe, and of 50.2-MeV α particles from ^{58}Ni, has been performed using independent real—and imaginary-potential-geometry parameters. The scattering is found to be sensitive only to the potential form at radial distances beyond about 6 F. Real-potential-parameter ambiguities have been studied with particular reference to the quality of the analyzed data. The potentials found are compared with expectations based upon a simple folding of matter sizes and effective two-body forces. (auth)

45769 LOW LYING LEVELS OF ^{55}Fe. El-Zaiki, M. I.; Megalaa, W. Z.; Saad, H. R.; Youssef, A. A. (Atomic Energy Establishment, Cairo). Z. Phys.; 234: 405-15(1970).

Angular distributions of 413 and 1,322 keV gamma rays from the ^{55}Mn(p,nγ)^{55}Fe reaction and the (n−γ) angular correlation measurements were measured at proton energies below 2.50 MeV. The experimental results show agreement with the Sheldon formula. The multipole mixture parameters for the 933 and 1,322 keV gamma rays in ^{55}Fe were determined. The sum coincidence technique is used to give some information about the scheme of excited levels in the ^{55}Fe nucleus. (auth)

45770 STUDY OF 0^+–0^+ TRANSITIONS IN ^{12}C, ^{24}Mg, ^{28}Si, ^{32}S, AND ^{40}Ca BY INELASTIC ELECTRON SCATTERING. Strehl, P. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 234: 416-42(1970). (In German).

Transitions from the 0^+ ground states to 0^+ excited states at 7.65 (^{12}C), 6.44 (^{24}Mg), 4.98 and 6.69 (^{28}Si), 3.78 (^{32}S) and 3.35 (^{40}Ca) MeV were studied with 28 to 60 MeV electrons at scattering angles from 105 to 165°. Matrix elements and transition radii were deduced, using DWBA-calculations. The monopole excitations can be uniquely distinguished from electric quadrupole excitations by the angular dependence of the cross sections. Some results for E2- and E3-transitions in ^{12}C, ^{28}Si, ^{32}S and ^{40}Ca are given, too. (auth)

45771 BAND MIXING IN ^{22}Ne. Johnstone, I. P.; Castel, B. (Queen's Univ., Kingston, Ont.). Lett. Nuovo Cim.; 3: 307-9 (7 Mar 1970).

A projected Hartree–Fock calculation was performed for ^{22}Ne. An effective interaction calculated by Kuo was used. The results are compared with an exact shell-model calculation, and the overall agreement is sufficiently good to justify the method. (J.W.R.)

45772 EXCITED LEVELS OF THE ^{84}Rb AND ^{86}Rb NUCLEI. Bucurescu, D. (Inst. of Atomic Physics, Bucharest); Ivascu, M.; Popescu, D.; Titirici, M.; Spilling, P. Rev. Roum. Phys.; 15: 711-13(1970).

Little information has been obtained so far on the excited states of the ^{84}Rb and ^{86}Rb nuclei by means of nuclear reactions. Thus, there is no study concerning the excitation of levels in the ^{84}Rb nucleus through a nuclear reaction. For the ^{86}Rb nucleus, a number of levels were studied by means of the (d,p), (d,t), (τ,α), and (n,γ) reactions. A small number of levels could be observed in the (d,t) reaction; also, in the (τ,α) reaction, only a few excited states were appreciably populated, as was observed or many other (τ,α) reactions on target nuclei in this mass region. In a recent investigation the ^{86}Sr(d,α)^{84}Rb and ^{88}Sr(d,α)^{86}Rb reactions were used in order to determine the position of excited levels in the two Rb isotopes, and to extract, whenever this is possible, information on the spin and parity values of these levels. As first results, the position of the levels observed in this experiment is reported. (auth)

45773 POSITIVE PARITY DEFORMED STATES IN ^{56}Ni AND ^{58}Ni. Jaffrin, A. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 32B: 448-50(17 Aug 1970).

Positive-parity states with a prolate deformation are constructed in the configuration space of ^{56}Ni and ^{58}Ni by diagonalizing a residual interaction in the basis of projected Slater determinants. A satisfactory description is obtained both for the ^{56}Ni energy spectrum and for the ^{58}Ni excitation spectrum seen in α-transfer experiments. (auth)

45774 LEVEL STRUCTURE OF ^{50}V. Bishop, J. N. (Univ. of Pennsylvania, Philadelphia); Pullen, D. J.; Rosner, B. Phys. Rev., C; 2: 550-6(Aug 1970).

The reaction ^{49}Ti(^{3}He,d)^{50}V has been studied at 15-MeV incident energy with an over-all energy resolution better than 20 keV full width at half maximum. 54 states were observed in ^{50}V up to 6-MeV excitation, and corresponding deuteron angular distributions were measured in the angular interval 7 to 50°. Spectroscopic information has been extracted for 30 of the stronger or well-isolated transitions by means of a distorted-wave analysis of the differential cross sections. The results are compared with nuclear-model predictions. (auth)

45775 PROPERTIES OF ^{29}Si AND ^{31}Si NUCLEI FROM DOPPLER-SHIFT ATTENUATION MEASUREMENTS. Wozniak, Matthew Joseph Jr. Tucson, Ariz.; Univ. of Arizona (1969). 137p.

Thesis.

A Ge(Li) detector was used in the coincidence version of the Doppler-shift attenuation method to obtain information concerning the mean lives of the low-lying states in ^{29}Si and ^{31}Si. From the mean life results the reduced matrix elements for electromagnetic transitions among some of the low-lying states in ^{29}Si and ^{31}Si were deduced. An extensive comparison was made between these values of the reduced matrix elements and those predicted by the extreme single-particle model, the Nilsson rotational model, and the shell model with configuration mixing in the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ shells. On the basis of the above comparisons, values of $J^\pi = \frac{7}{2}^+$ and $K = \frac{3}{2}$ are suggested for the spin, parity and rotational quantum numbers, respectively, of the 4.08-MeV state in ^{29}Si. A value of $\kappa = 0.10$ for the spin-orbit coupling parameter seems appropriate for both nuclei. Some information concerning the branching ratios of the states at 4.84, 4.89, and 4.93 MeV in ^{29}Si is also presented. A value of 752 ± 0.6 keV was obtained for the excitation energy of the 0.75-MeV state in ^{31}Si. (Diss. Abstr.)

45776 REACTION (^{3}He,d) ON ^{35}Cl AND ^{37}Cl AND THE STRUCTURE OF ^{36}Ar AND ^{38}Ar. Moinester, Murray Aaron. Rochester, N. Y.; Univ. of Rochester (1969). 187p.

Thesis.

The level structures of ^{36}Ar and ^{38}Ar were investigated with the ^{35,37}Cl(^{3}He,d)^{36,38}Ar reactions at a bombarding energy of 12 MeV and with a deuteron energy resolution of 12 keV. Deuteron angular distributions out to a laboratory angle of 40° were measured for 31 levels in ^{36}Ar up to 8.5 MeV excitation and 29 levels in ^{38}Ar up to 6.9 MeV excitation. The lp values and transition strengths were determined from a distorted wave Born analysis of the angular distributions. The results for the positive parity states of ^{36}Ar and ^{38}Ar are in reasonable agreement with a shell model calculation of Glaudemans, et al., which considers only $1d_{\frac{3}{2}}$ and $2s_{\frac{1}{2}}$ nucleons outside a closed ^{28}Si core. The major components of the $(f_{\frac{7}{2}}d_{\frac{3}{2}}^2)_{T=1}$ configuration in ^{38}Ar for $J^\pi = (3,4,5)$- and of the $(f_{\frac{7}{2}}d_{\frac{3}{2}}^2)_{T=0}$ configuration in ^{36}Ar for $J^\pi = (3,5)$- were identified. For the $f_{\frac{7}{2}}$ transitions in ^{38}Ar, and to a lesser extent in ^{36}Ar, the observed severe fragmentation of strength shows the importance of core polarization rather than a simple weak coupling model in describing the structure of these nuclei. All the $p_{\frac{3}{2}}$ transition strength to T< states was accounted for in ^{36}Ar but only 12% in ^{38}Ar. It appears that the $p_{\frac{3}{2}}$-$f_{\frac{7}{2}}$ single-particle energy splitting is significantly smaller in ^{36}Ar than in ^{38}Ar. The angular distributions of all known 3- states are consistent with mixed l = 1 + 3 transitions, showing that configurational admixtures between the $(p_{\frac{3}{2}}d_{\frac{3}{2}}^2)$ and $(f_{\frac{7}{2}}d_{\frac{3}{2}}^2)$ configurations are important. For example, in the lowest 3- state, the l = 1 component is 7% in ^{38}Ar and 14% in ^{36}Ar. The centroid data of the $(f_{\frac{7}{2}}d_{\frac{3}{2}}^2)$ configurations in nuclei from ^{36}Ar to ^{41}Ca are discussed and evaluated. A multipole centroid analysis (MCA) of twenty-one reliable centroid data is then carried out to determine the eight two-body matrix elements of the effec-

tive residual interaction between $d_{\frac{5}{2}}$ and $f_{\frac{7}{2}}$ nucleons. Predictions are made for the centroid energies in selected nuclei between ^{33}S and ^{41}Ca. The MCA matrix elements are compared to matrix elements deduced from realistic nucleon–nucleon interactions and from the standard Talmi method. (Diss. Abstr.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 44305, 44382, 45272, 45377, 45635, 45646, 45822, and 45833.

45777 (KFK-tr–326) THE RADIOACTIVE PROPERTIES OF THE ISOTOPES OF ELEMENT 103. Druin, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report JINR–P7-4755. 7p. (In German). Dep. CFSTI (U. S. Sales Only).

The experimental results reported in 1961 by Ghiorso et al. on the radioactive properties of isotopes of element 103 were in sharp opposition to experimental results obtained at Dubna. New experiments were made at Dubna to establish the properties of $^{255}103$. The results showed that the origin of the α emitter reported by Ghiorso with $E_\alpha = 8.6$ MeV and $T_{\frac{1}{2}} = 8 \pm 2$ sec remains unexplained. The Dubna experiments for such an isotope of element 103 with these decay properties were negative. Isotopes were found at Dubna which must arise in the irradiation of Cf with $^{10,11}B$ isotopes, but which were not reported by Ghiorso. The original identification by Ghiorso et al. of the new α emitter as $^{257}103$ was later repudiated by them and this activity was assigned to either $^{258}103$ or $^{259}103$ in contradiction to the experimental data reported. (J.S.R.)

45778 (KFK-tr–327) ROLE OF THE α-RADIOACTIVE BACKGROUND IN THE INVESTIGATION OF THE DECAY OF ELEMENT 104. Akap'ev, G. N.; Druin, V. A.; Rud', V. I.; Sun-Tszin-Yan, G. Ya. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Rosemarine Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report JINR–P7-4772. 9p. (In German). Dep. CFSTI (U. S. Sales Only).

The contribution of the Pb impurities to the α spectrum measured by Ghiorso et al. in the preparation of element 104 by the irradiation of ^{249}Cf targets with accelerated ^{12}C and ^{13}C ions was investigated by the irradiation of natural Pb targets with ^{12}C ions and a comparison of the two spectra. The results show that Pb impurities in the ^{249}Cf target are responsible for some intensive lines in the spectrum reported by Ghiorso. Well-known activities to be expected in the Ghiorso study were also not reported as being observed. An accurate critical analysis of the Ghiorso results is not possible because the experimental conditions were not reported. (J.S.R.)

45779 (ORNL-tr–2263) OBSERVATION OF NEW HIGH ENERGY GAMMAS OF ^{132}I. Ardisson, Gerard; Dalmasso, Josette; Ythier, Christian. Translated by Martha Gerrard and J. J. Pinajian (Oak Ridge National Lab., Tenn.), from Compt. Rend., Ser. B; 268: 96-9(1969). 5p. Dep. CFSTI.

The γ radiation of ^{132}I, formed from ^{132}Te, has been studied at high energy with the help of a pair spectrometer in which a n-i-p diode of Ge(Li) is the main detector. The higher resolution has permitted observation of 12 new gamma rays. (auth)

45780 SINGLE NEUTRON STATES IN (n,α) CLUSTER TRANSFER REACTIONS. Chatterjee, M. L.; Cindro, N.; Jurcevic, M.; Kulisic, P.; Tudoric, J. (Rudjer Boskovic Inst., Zagreb). pp 210-11 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45781 FISSION CROSS SECTIONS AND FISSION PROBABILITIES IN ^4He INDUCED FISSION OF ^{182}W, ^{183}W, ^{184}W. Moretto, Luciano G. (Univ., Pavia, Italy); Gatti, Raymond G.; Thompson, Stanley G. Gazz. Chim. Ital.; 100: 391-402(Apr 1970). (In Italian).

The first chance fission probability for the compound nuclei ^{188}Os and ^{187}Os was determined experimentally. The fission cross sections were determined for the reactions of ^{182}W, ^{183}W, and ^{184}W with ^4He. These fission cross sections are transformed in total fission probabilities by dividing them by total reaction cross sections obtained from an optical model calculation. By comparison of the different total fission probability curves one can obtain the first chance fission probabilities. Such probabilities are then compared with the predictions of the statistical model. (auth)

45782 ELASTIC SCATTERING OF 50.8 MeV PROTONS FROM THE EVEN SAMARIUM ISOTOPES. Fulmer, C. B.; Kingston, F. G.; Scott, A.; Hafele, J. C. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 32B: 454-6(17 Aug 1970).

Angular distributions were measured over the angular range of 12° to 130°. Forward of ≈60° the angular distributions are very similar; at larger angles the amplitude of the oscillations increases and the cross sections decrease with increasing target deformation. (auth)

45783 K-SHELL CONVERSION COEFFICIENT OF THE 756.5-keV TRANSITION IN ^{141m}Nd DECAY. Grecescu, M.; Ionescu, V. A.; Galateanu, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 323-8(1970).

The multipolarity of the 756.5-keV isomeric transition in ^{141}Nd is established as M4 by a conversion coefficient measurement ($\alpha_K = 0.084 \pm 0.012$), in agreement with shell-model prediction. (auth)

45784 PARTICLE-VIBRATION DOORWAY RESONANCE IN ^{209}Pb. Beres, William P. (Wayne State Univ., Detroit); Divadeenam, M. Phys. Rev. Lett.; 25: 596-9(31 Aug 1970).

With no free parameters the particle-vibration model is used to describe the $\frac{1}{2}^+$ doorway resonance observed in ^{209}Pb at 500 keV with a width of 58 keV. It is found that the $(2g_{\frac{9}{2}}, 4^+)$ state which occurs at nearly the experimental energy has a width of about 1 to 2 times the measured value. (auth)

45785 EFFECTIVE TOTAL NEUTRON CROSS SECTIONS FOR ANTIMONY AT 30 TO 150 eV. Mateiciuc, V.; Aldea, L.; Constantinescu, M.; Stadnicov, T. Rev. Roum. Phys.; 15: 339-42(1970). (In French).

Experimental results are given on the neutron total cross sections of Sb at 30- to 150-eV incident energy. Calculations were made of the level spacing ⟨D⟩ and the intensity $\langle \Gamma_n^0 \rangle / \langle D \rangle$. Parameters for $^2g\Gamma_n$ for Sb resonances in the energy range from 30 to 150 eV are tabulated. (tr-auth)

45786 EFFECTIVE INTERACTIONS IN HEAVY NUCLEI. Butsana, Z. (Univ. of Lovanium, Kinshasa, Congo). pp 469-78 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The low-energy levels in ^{91}Zr and in nuclei with a small number of nucleons outside the closed shells Z = 82 and N = 126 were studied. The matrix elements derived from the ^{210}Po, ^{210}Bi and ^{210}Pb spectra made it possible to calculate the binding energies of the nuclei studied as well as several excited levels, notably in ^{212}Bi and ^{212}At. Isomeric states are predicted or confirmed. The positive parity levels of ^{91}Zr are also studied, taking into account the orbits $\nu d_{\frac{5}{2}}$, $\nu s_{\frac{1}{2}}$, $\nu d_{\frac{3}{2}}$ and $\nu g_{\frac{7}{2}}$ available to the 51st neutron and the orbits $\pi p_{\frac{1}{2}}$ and $\pi g_{\frac{9}{2}}$ available to the protons outside the shell Z = 38. The results obtained are in reasonable agreement with experimental data. (auth)

45787 STUDIES ON THE SPECTRA OF CONVERSION ELECTRONS EMITTED IN THE REACTION $^{149}Sm(n,\gamma)^{150}Sm$. Lindsay, J. E. O. (Ghana Atomic Energy Commission, Accra). pp. 481-5 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The results of studies on the spectrum of conversion electrons of samarium-150 emitted after thermal neutron capture in the reaction $^{149}Sm(n,\gamma)^{150}Sm$ are presented. The measurement was carried out using a beta spectrograph with a homogeneous magnetic field and broad electron beam focussing. The spectrum of the internal conversion electrons was measured by the photographic method. Besides the known lines observed and reported previously by such authors as Groshev et al., and Egidy et al., in the spectrum of the samarium-150 nuclide in the comparable energy range covered by the present studies, a number of new lines, particularly in the soft region of the spectrum, are reported. (auth)

45788 HIGH-ENERGY GAMMA-RAY SPECTRUM FROM SPONTANEOUS FISSION. Sobel, Henry Wayne. Cleveland; Case Western Reserve Univ. (1969). 116p.

Thesis.

A large shielded liquid scintillator detector operating 3,240 meters below the surface was used to look at gamma rays from the spontaneous fission of a uranium-238 source. A spectrum of Photons Fission^{-1} MeV^{-1} is obtained in an energy range from 8 to 20 MeV. (Diss. Abstr. Int., B)

45789 EVIDENCE FOR A TWO-PHONON OCTUPOLE VIBRATIONAL BAND IN ^{240}Pu. Schmorak, M. R. (Oak Ridge National Lab., Tenn.); Bemis, C. E. Jr.; Zender, M.; Coffman, F. E.; Ramayya, A. V.; Hamilton, J. H. Phys. Rev. Lett.; 24: 1507-11(29 Jun 1970).

A rotational band with $K^{\pi} = 0^+$ with I = 0 and I = 2 at excitation energies of 1410.8 and 1438.5 keV, respectively, was identified and carefully characterized in ^{240}Pu. It was concluded that these states are members of a two-phonon octupole vibrational band. (auth)

45790 COULOMB BREAKUP OF ^{8}Li ON ^{208}Pb. Speth, E.; Pfeiffer, K.-O.; Bethge, K. (Univ., Heidelberg). Phys. Rev. Lett.; 24: 1493-4(29 Jun 1970).

The breakup of ^{8}Li in the Coulomb field of ^{208}Pb was studied at 20-, 21-, 24-, and 26-MeV incident energy. The discrepancies between the experimental and theoretical values indicate that some of the simplifying assumptions of the theoretical description have to be improved. (auth)

45791 NEW ELEMENT HAHNIUM, ATOMIC NUMBER 105. Ghiorso, Albert; Nurmia, Matti; Eskola, Kari; Harris, James; Eskola, Pirkko (Univ. of California, Berkeley). Phys. Rev. Lett.; 24: 1498-1503(29 Jun 1970).

An isotope of element 105 with mass number 260 was formed by bombarding ^{249}Cf with ^{15}N ions. The Z and A of the nuclide were unambiguously identified by recoil-milking the 30-second ^{256}Lr daughter. ^{260}105 has a (1.6 ± 0.3)-sec half-life and decays by alpha-particle emission with groups at 9.06 (55%), 9.10 (25%), and 9.14 MeV (20%). Branching decay by spontaneous fission is less than 20%. Some comments are made on the earlier results of the Dubna group concerning a few alpha-particle events at 9.4 and 9.7 MeV which they claim to be due to element 105. (auth)

45792 POLARIZATION IN COULOMB STRIPPING REACTIONS. Griffith, J. A. R.; Roman, S. (Univ. of Birmingham, Eng.). Phys. Rev. Lett.; 24: 1496-8(29 Jun 1970).

Distorted-wave Born-approximation calculations of polarization effects in (d,p) stripping reactions near the Coulomb barrier were carried out which predict large polarization values and strongly j-dependent patterns for the angular distributions of polarization. Coulomb-wave calculations showed that for reactions in the Coulomb field the coupling of the orbital angular momentum to the spin of the captured neutron is simply related to the predominant sign of the polarization. (auth)

45793 ENERGY DEPENDENCE OF BETA–GAMMA CIRCULAR POLARIZATION CORRELATION IN ^{140}La. Ohlms, Daniel Edward. Lafayette, Ind.; Purdue Univ. (1969). 97p.

Thesis.

The dependence of the beta-gamma circular polarization correlation on beta energy for the 2.2-MeV beta transition in ^{140}La was studied. The circular polarization of the gamma ray was measured using the technique of forward Compton scattering from magnetized iron. To obtain the required statistical accuracy special high counting rate electronics and stabilizing techniques were employed. The performance of the instrument was checked by measuring the energy dependence of the beta-circularly polarized gamma correlation for ^{60}Co. The expected v/c cos θ dependence was observed. For ^{140}La a relative difference in counting rate of −.0148 ±.0038 and −.0088 ±.0045 was found for beta total energies of 4.15 and 4.94 natural units respectively. An analysis of this data and previous measurements on the spectrum shape and the energy dependence of the directional correlation was performed using the method of Simms. The following limits can be placed on the nuclear matrix element parameters, defined relative to z = 1.0; −.2698 > D'y > −.5671, −1.8485 > x > −3.8856, −1.0523 > u > −2.3513. The ratio D'y/x does not agree with the prediction of Fujita using the CVC theory. However, agreement with the CVC theory is possible if the more detailed treatment of Damgaard and Winther is used. (Diss. Abstr. Int., B)

45794 MEASUREMENT OF SOME NUCLEAR PARAMETERS IN THE RADIOACTIVE DECAY OF ^{143}Ce, ^{171}Er, AND ^{97}Zr. Megli, Darrell George. Manhattan, Kan.; Kansas State Univ. (1969). 83p.

Thesis.

The radiations emitted in the decay of ^{143}Ce, ^{171}Er and ^{97}Zr were studied with Ge(Li) and scintillation detectors in conjunction with multichannel and multiparameter analyzers. Sources of ^{143}Ce (33 hour half-life) were produced by thermal neutron capture in samples of CeO_2 enriched to 90.5 percent in ^{142}Ce. The energies and relative intensities of 21 gamma-ray transitions emitted in the decay of ^{143}Ce were measured. The energies are 57, 233, 293, 352, 371, 390, 435, 448, 490, 555, 586, 665, 721, 808, 880, 937, 1004, 1032, 1061, 1102 and 1325 keV. Beta-gamma and gamma-gamma coincidence experiments along with energy considerations provide a nuclear structure diagram for ^{143}Pr containing 8 excited states. Log ft values suggest first forbidden transitions to all 8 excited levels. The energies in keV and spin-parity parameters for the levels in ^{143}Pr are 0($1/2^+$), 57($5/2^+$), 351($3/2^+$), 491($5/2^+$,$1/2^+$), 722($3/2^+$,$5/2^+$), 937($3/2^+$,$5/2^+$), 1061($3/2^+$,$5/2^+$,$1/2^+$), 1158($1/2^+$,$3/2^+$,$3/2^+$,$1/2^+$), and 1382($1/2^+$,$3/2^+$,$5/2^+$,$1/2^+$). Samples of Er_2O_3 (isotopic concentration of ^{170}Er 96.06 percent) were irradiated by thermal neutrons to produce ^{171}Er (measured half-life 7.8 ± 0.2 hours). The gamma-ray spectrum contains 34 full energy peaks at 112, 117, 124, 211, 236, 276, 296, 308, 360, 372, 420, 508, 520, 547, 559, 573, 608, 620, 671, 676, 732, 744, 785, 797, 870, 883, 908, 966, 1097, 1110, 1171, 1222, 1284 and 1400 keV. Broadened peaks suggest the additional presence of quanta at 425, 913, 1271 and 1395 keV. Evidence has been obtained for the existence of excited levels in ^{171}Tm at 5, 117, 129, 425, 489, 637, 737, 861, 913, 1000, 1226 and 1400 keV. Additional levels have been proposed at 966 and 1171 keV. Nilsson numbers $1/2^+\{411\}$, $7/2^-\{523\}$, $7/2^+\{404\}$, $5/2^+\{402\}$, $3/2^+\{411\}$ and $5/2^+\{413\}$ have been assigned to the ground state, 425, 489, 637, 676, and 913 keV levels, respectively. The first three excited levels make up a rotational band built on the ground state of ^{171}Tm and the 737 and 861 keV levels are thought to form a rotational band built on the 676 keV level. Sources of ^{97}Zr (17 hour half-life) were produced by thermal neutron capture in samples of ZrO_2 (enrichment in ^{96}Zr 85.25 percent). In spectra of single counts full energy peaks appear at 112, 218, 254, 272, 296, 330, 355, 400, 508, 514, 602, 691, 704, 743, 804, 829, 855, 971, 1021, 1148, 1276, 1363, 1750 and 1852 keV. In gamma-gamma coincidence spectra additional full energy peaks appear at 183, 202, 304, 410, 474, 558, 699, and 707 keV. Considerations of the decay scheme and gamma-gamma coincidence data require the 218, 508, and 602 keV peaks to be doublets. Although these are unresolved the 508 keV full energy peak does exhibit an asymmetrical shape. The proposed level scheme for ^{97}Nb contains levels at 743, 1148, 1251, 1276, 1434, 1548, 1652, 1750, 1765, 1852, 1958, 2056, 2106 and 2247 keV excitation. (Diss. Abstr.)

45795 DECAY OF ^{160}Tb TO LEVELS IN ^{160}Dy. Ludington, Martin Authur. Ann Arbor, Mich.; Univ. of Michigan (1969). 79p.

Thesis.

The gamma radiation associated with the beta decay of ^{160}Tb to levels in ^{160}Dy was studied with a curved-crystal spectrometer and Ge(Li) spectrometers. Gamma–gamma coincidence studies using two Ge(Li) detectors were performed. A total of 32 gamma-ray energies and intensities were measured. Five previously unreported transitions were observed with energies 237.638 ± 0.086 keV, 246.489 ± 0.016 keV, 349.94 ± 0.11 keV, 1005.0 ± 1.0 keV and 1068.9 ± 1.5 keV. The existence of transitions at 176, 379, 486, 872 and 1286 keV was confirmed. A decay scheme is given which incorporates all of the transitions observed in this study. It is essentially that given by previous investigators with the addition of levels at 1155.8, 1288.7 and 1535.2 keV. The level at 1155.8 keV was identified as the 4 member of the gamma-vibrational band. Spin, parity and K quantum number assignments are discussed for the other levels in the decay scheme. A comparison is made of the results of the present study with previous investigations. Two rotational bands coupled with octupole vibrations are postulated and compared with the recent calculations of Soloviev for the superfluid model. (Diss. Abstr.)

45796 GAMMA-RAY SPECTROSCOPIC STUDY OF THE DECAYS OF ^{124}Sb AND ^{126}I. Auer, Ivan Paul. Ann Arbor, Mich.; Univ. of Michigan (1969). 132p.

Thesis.

The gamma-ray spectra associated with the decay of the 60 day ^{124}Sb and the 13 day ^{126}I were studied with high resolution Ge(Li) spectrometers and with NaI(Tl)–Ge(Li) and Ge(Li)–Ge(Li) gamma–gamma coincidence spectrometers. In addition, the gamma-ray energies associated with ^{124}Sb were also measured with bent crystal spectrometers. Energies and intensity measurements of 38 gamma-rays of ^{124}Sb are reported. A partial decay scheme is proposed which incorporates 34 of the 38 observed gamma-rays. The energies of the proposed levels are: 602.71, 1248.56, 1325.53, 1957.98, 2039.34, 2091.77, 2182.48, 2293.73, 2322.87, 2483.27, 2521.77, 2693.74, 2701.78, 2710.65, and 2774.88 keV. The energies and intensities of six of the gamma-rays of ^{126}I were measured as well as the relative intensities of the annihilation radiation. The study confirms the accepted decay scheme of ^{126}I. The energies of the gamma-rays are: 388.585 ± 0.045, 491.250 ± 0.045, 666.350 ± 0.052, 753.820 ± 0.064, 879.892 ± 0.082, and 1420.130 ± 0.086 keV. A discussion of the level schemes of ^{124}Te, ^{126}Te, and ^{126}Xe incorporating the results of other investigators is presented. The computer programs that were developed to help analyze the data are briefly described.

One of the programs was written to estimate peak positions and areas of count distributions using a square root transformation in a modified χ^2 analysis. Another program was written to generate and fit orthogonal polynomials to data taken at equally spaced intervals. (Diss. Abstr.)

45797 E1 TRANSITIONS FROM THE SEPTUPLET IN ^{209}Bi. Harada, K. (Bartol Research Foundation, Swarthmore, Pa.). Phys. Rev. Lett.; 24: 1438-40(22 Jun 1970).

E1 transition rates from the septuplet of ^{209}Bi are analyzed using a simple model in which a direct coupling between the octupole and the dipole states of the core nucleus ^{208}Pb is taken into account. It is shown that by using reasonable parameters one can get results which are consistent with the observed decay rates. (auth)

45798 HEAVY FRAGMENT EMISSION IN HIGH ENERGY REACTIONS ON HEAVY NUCLEI. Remy, G.; Ralarosy, J.; Stein, R.; Debeauvais, M.; Tripier, J. (CNRS, Strasbourg). J. Phys. (Paris); 31: 27-34(Jan 1970).

Three prong events, registered in plastic visual detectors were studied and calculated, and their cross sections for various targets and various incoming energies were compared with binary fission cross sections. Angular, energy and fragment mass distribution are also given. (auth) (France)

45799 THE DECAY OF ^{151}Gd TO THE LEVELS OF ^{151}Eu. Ford, J. W. (Vanderbilt Univ., Nashville); Ramayya, A. V.; Pinajian, J. J. Nucl. Phys.; A146: 397-409(1970).

The γ-rays of ^{151}Eu were investigated with a 35 cm^3 Ge(Li) detector coupled to a 4096-channel analyzer. Gamma rays of the following energies and intensities (in parenthesis) were found to decay with the half-life of ^{151}Gd: 106.51 ± 0.06(1.29), 110.53 ± 0.11(0.12), 153.57 ± 0.06(100), 174.65 ± 0.06(48.3), 196.46 ± 0.09(0.45), 239.00 ± 0.14(2.31), 243.22 ± 0.06(89.9), 260.39 ± 0.09(0.84), 286.00 ± 0.09(1.35), 307.43 ± 0.09(16.5), 328.23 ± 0.09(1.32), 332.13 ± 0.12(0.17) and 353.51 ± 0.09(2.04). Using the energy sum rules and coincidence relationships the levels at 21.54, 196.21, 196.46, 243.22, 260.44, 306.99, 307.47, 349.76 and 353.56 keV are proposed for ^{151}Eu. A decay scheme consistent with the results is presented. The present studies support the previously proposed collective states. (auth)

Nuclear Theory

Refer also to abstracts 45002, 45470, 45485, 45547, 45549, 45563, 45627, 45733, 45744, and 45766.

45800 (RT/FI-(69)30) BOSTAW: A FORTRAN PROGRAMME FOR THE CALCULATION OF THE NUCLEON BOUND STATES IN A WOODS-SAXON WELL. Fabbri, F.; Saruis, A. M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 25 Jul 1969. 17p. Dep. CFSTI (U. S. Sales Only).

A description of the program BOSTAW, written in FORTRAN IV for IBM 7094 computer is given. The program computes the nucleon bound eigenfunctions and eigenvalues in a Woods-Saxon well. (auth)

45801 (STI/PUB-232) CLUSTERING PHENOMENA IN NUCLEI. Proceedings Series. Invited Lectures and Contributed Papers from the International Conference held in Bochum, 21-24 July 1969. (International Atomic Energy Agency, Vienna (Austria)). 1969. 365p. (CONF-690717). IAEA $10.00.

Separate abstracts were prepared for the 15 invited papers included. Thirty-six of the 53 contributed papers are listed by title only. The remaining 18 papers, which are short summaries, are not listed. (J.W.R.)

For abstracts of individual papers see: 45723-45728, 45733-45750, 45765-45767, 45780, and 45802-45824.

45802 CLUSTER REPRESENTATIONS AND NUCLEAR STRUCTURE. Wildermuth, K. (Univ., Tuebingen, Ger.). pp 3-15 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

An attempt is made to show that the method of cluster representations together with the Rayleigh-Schroedinger variational principle is a promising way to arrive at a unified nuclear structure and reaction theory. (L.W.A.)

45803 CLUSTER EFFECTS IN NUCLEAR REACTIONS. Holmgren, H. D. (Univ. of Maryland, College Park). pp 17-34 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The development of the concept of cluster effects in nuclear reactions is discussed. Experimental methods for determining cluster effects—α-particle capture reactions, elastic scattering of various projectiles by nuclei, direct reactions such as stripping and pick-up—are presented. The use of reactions which are to a large extent quasi-free cluster-knock-out processes to obtain information about the cluster structure of nuclei is discussed. (L.W.A.)

45804 MANIFESTATIONS OF NUCLEON CLUSTERING IN LIGHT NUCLEI. Neudatchin, V. G. (Moscow State Univ.). pp 35-44 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The properties of light nuclei which are the manifestations of nucleon clustering are described. A detailed discussion of the cluster structure of ^{6}Li and ^{9}Be is presented. The cluster properties of heavier nuclei in the p-shell region are also discussed. (J.W.R.)

45805 QUASI-ELASTIC KNOCK-OUT OF CLUSTERS. Balashov, V. V. (Moscow State Univ.). pp 59-72 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The quasi-elastic knock-out of deuterons, alpha particles, and other complex particles from nuclei is discussed in terms of being evidence for the cluster structure of nuclei. The quasi-elastic scattering process is described as a three-body problem and then as a many-particle and many-channel effects problem. (L.W.A.)

45806 MULTI-PARTICLE FINAL STATES. Phillips, G. C. (Rice Univ., Houston, Tex.). pp 73-86 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The study of multi-particle final states for the purpose of developing and testing cluster models is described. Some of the recent experimental progress on multi-particle break-up studies is surveyed. Sequential and simultaneous decay, direct knock-out reactions, and determination of scattering lengths and excitation functions are discussed. (J.W.R.)

45807 EVALUATION OF DALITZ PLOTS. Kamke, D. (Ruhr-Univ., Bochum, Ger.). pp 87-107 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

Problems resulting from the evaluation of coincidence rate plots are discussed. A three particle system in a laboratory system is represented by a distribution of events in a tetrahedron of reduced energies. Experimental data are evaluated directly through inner and outer parameters which are calculated from the experimental data. The parameters show to what extent the angular correlation functions influence the outcome of an experiment that measures level data of an intermediate nucleus of a multi-particle reaction. (L.W.A.)

45808 FEW-NUCLEON SYSTEMS AND EFFECTIVE INTERACTION OF CLUSTERS. Tang, Y. C. (Univ. of Minnesota, Minneapolis). pp 109-28 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

Calculations of light-nuclei scattering cross sections by the resonating-group structure method are discussed. The uses of the results of the calculations—providing a starting point for a detailed phase-shift analysis, predicting the presence of resonance levels in light nuclei, obtaining a better understanding of the importance of the Pauli principle in studying the properties of a many-body system, and constructing effective two-body potentials between nucleon clusters—are discussed. (L.W.A.)

45809 GENERAL TREATMENT OF REACTIONS. Hackenbroich, H. H. (Univ. of Cologne). pp 129-35 of Clustering

Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The treatment of nuclear reactions through the use of a nucleon–nucleon interaction without introducing model parameters is discussed. It is shown that the familiar cluster model scattering theory cannot be extended to a multi-channel reaction theory, and consequently a theory based on cluster model ideas which allows a more flexible description of the wave functions in the interaction region and the treatment of soft core forces is developed. (L.W.A.)

45810 "MOLECULAR-ORBIT" TREATMENT OF CLUSTERING. Tanaka, H. (Hokkaido Univ., Sapporo). pp 137-45 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The conditions controlling the appearance of clustering in nuclei are described. The repulsive interaction between two clusters is examined in detail. The "atomic orbit" treatment of clustering effects is discussed. The development of "molecular orbits" as linear combinations of "atomic orbits" is described. Some illustrations of the molecular orbit treatment for light nuclei are given. (J.W.R.)

45811 GENERATOR COORDINATE METHOD AND GEOMETRY OF ALPHA CLUSTERS. Brink, D. M. (Institut de Physique Nucleaire, Orsay, France). pp 147-52 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The various methods that have been proposed for developing alpha-cluster models are discussed. Cluster correlations in Slater-determinant wave functions for ^{8}Be are analyzed. The generator-coordinate method is described and compared with the resonating group method. (J.W.R.)

45812 TRANSLATIONALLY INVARIANT SHELL MODEL. Smirnov, Yu. F. (Moscow State Univ.). pp 153-62 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

A description for the cluster structure of light nuclei using the translationally-invariant shell model is presented. (J.W.R.)

45813 GROUP THEORY AND THE SUPERMULTIPLET SCHEME. Kramer, P. (Univ., Tuebingen, Ger.). pp 163-73 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The use of the supermultiplet scheme in treating problems arising from transformation properties in the cluster model is described. Some examples for light nuclei are presented. (J.W.R.)

45814 NUCLEAR FISSION AND THE CLUSTER MODEL. Goennenwein, F. (Univ., Tuebingen, Ger.). pp 175-87 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The various models developed for describing the fission process are discussed. The faults of the conventional liquid-drop model are pointed out. The formulation of a cluster model of nuclear fission is outlined. Some computational results with the model are illustrated and compared with experiment. (J.W.R.)

45815 TRANSFORMATION BRACKETS FOR THREE- AND FOUR-NUCLEON SYSTEMS. Moshinsky, M. (Univ. of Mexico, Mexico City. Comision Nacional de Energia Nuclear, Mexico City). pp 189-96 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

The concept of the transformation bracket for harmonic oscillator states is applied to translationally-invariant three- and four-nucleon systems. Some results are presented. (J.W.R.)

45816 SPATIALLY CORRELATED α-CLUSTERS AND GROUND STATE CORRELATIONS IN THE SHELL MODEL. Eichler, J. (Hahn Meitner Inst. for Nuclear Research, Berlin); Kamimura, M.; Marumori, T.; Takada, K. pp 269-70 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45817 FOUR-BODY POTENTIAL IN NUCLEAR HARTREE–FOCK CALCULATIONS. Boffi, S.; Campagnoli, G. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). pp 271-4 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45818 SHORT-RANGE CORRELATIONS IN NUCLEI. Malecki, A. (Inst. of Nuclear Physics, Krakow. International Atomic Energy Agency, Trieste, Italy). pp 289-90 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45819 SOFT CORE NUCLEON–NUCLEON POTENTIAL. Eikemeier, H. (Univ., Tuebingen, Ger.); Hackenbroich, H. H. pp 291-3 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45820 NEW UNIFIED MODEL FOR CLUSTER AND SHELL STRUCTURES OF LIGHT NUCLEI. Abe, Y. (Hokkaido Univ., Sapporo). pp 303-4 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45821 PAULI PRINCIPLE AND THE STRUCTURE OF NUCLEI. Risser, J.; Wildermuth, K. (Rice Univ., Houston, Tex.). pp 305-7 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45822 INTRINSIC MOTION AND TRANSLATION-INVARIANCE IN SHELL MODEL CALCULATIONS. EFFECTS OF TRANSLATION-INVARIANCE VIOLATION ON ^{208}Pb. Palumbo, F.; Prosperi, D. (Centro di Studi Nucleari, Casaccia, Italy. CNEN, Rome). pp 323-4 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45823 CONSEQUENCES OF INTERNAL SYMMETRY PROPERTIES ON NUCLEON CORRELATIONS IN NUCLEI. Burdet, G. M. N.; Maguin, C.; Partensky, A. (Univ., Lyon). pp 325-6 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45824 ANTISYMMETRIC STATES OF THE CLUSTER MODEL AND THEIR α-PARTICLE PARENTAGE. Hutzelmeyer, H. (Univ., Cologne); Kramer, P.; Seligman, T. H. pp 327-8 of Clustering Phenomena in Nuclei. Vienna; International Atomic Energy Agency (1969).

From International Conference on Clustering Phenomena in Nuclei, Bochum, West Germany. See STI/PUB-232; CONF-690717.

45825 MESON THEORY OF NUCLEAR FORCES. Coester, F. (Argonne National Lab., Ill.). pp 147-65 of Quanta. /Freund, P. G. O. (ed.). Chicago; University of Chicago Press (1970).

The importance of more fundamental theories that derive the effective nucleon–nucleon Hamiltonian from a knowledge of the internal degrees of freedom of the nucleon is emphasized. The formal framework for constructing a reduced Hamiltonian for a subsystem from the Hamiltonian of the full system is reviewed. A simple model that yields the conventional one-meson exchange potentials is discussed. The main qualitative features of relativis-

tic models of particle interactions without fields are examined. (L.B.S.)

45826 NUCLEAR-SCATTERING PROBLEM IN THE GENERALIZED HARTREE–FOCK APPROXIMATION. Celenza, Louis S. (Brooklyn Coll.). Phys. Rev., C; 2: 349-56(Aug 1970).

The generalized Hartree – Fock approximation of Kerman and Klein is extended to include continuum states of a collective nature. The equations for scattering in the random-phase approximation are rederived. (auth)

45827 EXTENSION OF TWO-NUCLEON TRANSFER THEORY TO INCLUDE INELASTIC PROCESSES. Ascuitto, R. J.; Glendenning, Norman K. (Univ. of California, Berkeley). Phys. Rev., C; 2: 415-21(Aug 1970).

The theory of two-nucleon transfer reactions is extended to include higher-order transitions going through intermediate nuclear states produced by inelastic scattering of the ingoing or outgoing particle. The reaction, as is usual, is treated to first order, but the inelastic processes are treated to all orders among the retained channels. The theory is formulated so that it is very easily applied to any microscopic structure calculation, since the relevant content of such calculations appear in the theory only through the values of the matrix elements of the pair-creation $[d^\dagger d^\dagger]_J$ and scattering $[d^\dagger \tilde{d}]_J$ operators. (auth)

45828 KOHN'S VARIATIONAL PRINCIPLE FOR REARRANGEMENT COLLISIONS. Tikochinsky, Y. (Rutgers–The State Univ., New Brunswick, N. J.). Ann. Phys. (N. Y.); 59: 74-9(Jul 1970).

By rewriting the Gell–Mann Goldberger transformation, a generalized Kato identity is obtained both in its prior and post forms. Dropping the second order terms from these identities, the prior and post forms of Kohn's variational principle are secured. The principle is applied to the discussion of the (d,p) reaction. It is shown that the DWBA amplitude for this reaction is a variational solution of the problem and as such is free from the theoretical difficulties associated with the perturbative approach. (auth)

45829 SEMI-CLASSICAL ESTIMATE OF CRITICAL CHARGES IN COULOMB FISSION. Kelson, I. (Tel-Aviv Univ., Israel). Phys. Lett.; 32B: 445-7(17 Aug 1970).

Coulomb fission is argued semi-classically to have sizable cross sections only when the fission-inducing ion is above some critical charge. As a preliminary, rough number Z = 50 is obtained for that charge. (auth)

45830 COMPARISON BETWEEN DIFFERENT ESTIMATES OF A RESONANT STATE LIFETIME. Lejeune, A. (Univ., Liege). Z. Phys.; 234: 391-7(1970).

In the frame of a soluble coupled channels model the exact lifetime τ of a resonant state is compared with two approximate estimates for this τ. The exact τ value is related to the exact total width Γ by $\tau = \hbar\Gamma^{-1}$. The first approximate method has been derived by Fermi. It consists in a first order perturbation calculation of Γ. The second one is Smith's time-delay method which leads to a direct relation between τ and the behavior of the S-matrix along the real energy axis. It is shown that the Smith's method is the most useful one. (auth)

45831 CALCULATION OF BETA-DECAY OBSERVABLES. Bogdan, D.; Cirjan, N.; Piticu, I.; Protop, C.; Vata, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 355-68 (1970).

A correct calculation of the beta decay observables must necessarily take into account the rigorous radial dependence of the electron wave functions (the solutions of the Dirac radial equation for an extended uniform nuclear charge distribution). This implies the occurrence of the matrix elements of the $\int T_{Lls}\,(r/R)^2$ type in addition to $\int T_{Lls}$ and also the use of exact Coulomb functions. The high-forbidden matrix elements must also be taken into account. In addition, the deformed part of the Coulomb potential in the correct formula connecting the $\int\vec{\alpha}$ and $\int i\vec{r}$ matrix elements, whenever deformed nuclei are investigated, must be considered. This is illustrated by computer calculations on observables in the first-forbidden transitions ^{193}Au ($^7/_2^+ \rightarrow {}^1/_2^-$), ^{198}Au ($2^- \rightarrow 2^+$), ^{188}Re ($1^- \rightarrow 2^+$), ^{186}Re ($1^- \rightarrow 2^+$), and ^{166}Dy ($0^+ \rightarrow 1^-$). (auth)

45832 SINGLE-PARTICLE RESONANCES IN THE UNIFIED THEORY OF NUCLEAR REACTIONS. Wang, W. L.; Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett.; 32B: 421-4(17 Aug 1970).

A method for the treatment of single-particle resonances in the theory of nucleon–nucleus scattering is introduced which finds application in the projection operator theory of Feshbach. The example of the $d_{\frac{5}{2}}$ neutron resonance in the scattering from ^{16}O is discussed. (auth)

45833 RECOIL STUDIES OF (α,n) REACTIONS AT INTERMEDIATE ENERGIES. Swanson, David Gilbert Jr. Lafayette, Ind.; Purdue Univ. (1969). 225p.

Thesis.

A calculation of the angular distribution of recoil products resulting from compound nuclear (α,n) reactions was programmed on the basis of the spin-dependent statistical theory of nuclear reactions. The program is based on the Monte Carlo technique, considers the emission of neutrons, protons, alpha particles and gamma rays, and uses either the Fermi gas or superconductor models of the nucleus. The computed angular distributions were compared with the experimental results for various (α,n) reactions and, in agreement with experiment, exhibit a smooth drop-off from a peak close to 0°. This contrasts with the marked disagreement between the experimental results and previous spin-independent calculations which predicted a peak at large angles to the beam. The difference is ascribed to the effect of competitive γ-ray emission, which is not adequately considered in spin-independent calculations. The present calculation predicts a faster decrease with angle in the magnitude of the differential cross section than is observed experimentally. This result is independent of the specific parametrization of the calculation and may reflect a small contribution from direct interactions. In order to test the calculation a series of experiments were performed in which the angular distributions of recoil products from the ^{134}Ba(α,n)^{137m,g}Ce reaction were measured. The recoil ranges for the ^{134}Ba(α,n) reaction are consistent with a compound nuclear mechanism over the energy range from 15 to 28 MeV. In addition to the average ranges, the excitation function and isomer ratios were measured for the ^{134}Ba(α,n) reaction. The experimental isomer ratios and the excitation function agree well with the results of the spin dependent statistical model calculation. The angular distributions of ^{137m}Ce and ^{137g}Ce nuclei formed in the ^{134}Ba(α,n) reaction were studied at three different energies in the range between 18 and 25 MeV. Satisfactory agreement was obtained between theory and experiment at small angles. At large angles the calculated angular distribution was smaller than expected from the experimental data. The discrepancy can be attributed to a contribution from the direct interaction mechanism. Average properties of the angular distributions have been used to obtain the average values of the particle and photon energies. An angular distribution calculation for a hypothetical nucleus suggests that it may be possible to observe spin fractionation experimentally. (Diss. Abstr. Int., B)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 44137, 44226, and 45994.

45834 (CONF-700810-39) ROLE OF NUCLEAR POWER IN THE UNITED STATES. Thompson, Theos J. (Atomic Energy Commission, Washington, D. C.). 10 Aug 1970. 41p. (SM-146/4). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Continued development and growth of nuclear power is destined to play a prominent part in easing the problem of population growth and industrial development. The current status of nuclear power in the United States of America includes full capability to manufacture nuclear power plants, substantial atomic energy employment, and heavy utility commitments for future nuclear power plants. Today, over 100 commercial nuclear electric generating plants are in operation, under construction or planned. Nuclear science and engineering is a definite field of study in many of our major universities. Nuclear power as a new source of energy has the potential to extend our available resources of hydrocarbon fuels and permit their use for unique applications. It also acts as a competitive spur on coal production and transportation industries to reduce costs. Very large future U.S. energy requirements will be characterized by an increasing proportion of electrical energy and rapid growth in the use of nuclear power. Emphasis is being given to the need for breeder reactors to extend resources of nuclear materials greatly beyond limits set by present-type reactors. Concentration of energy sources in large, low-cost nuclear electrical generating stations may result in future improvement of living standards through the use of multipurpose energy complexes for a variety of energy-intensive applications. Potential contributions of nuclear power to environmental control will include not only the inherent pollution-free aspects of nuclear power but also the availability of low-cost nuclear power to meet the substantial energy requirements for environmental control. (28 references) (auth)

45835 (CONF-700810-46) ROLE OF NUCLEAR POWER IN MEETING WORLD ENERGY NEEDS. Spinrad, B. I. (International Atomic Energy Agency, Vienna (Austria)). [1970]. 34p. (SM-146/2). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

By 1980, about one sixth of the world's electricity production will come from nuclear fission energy, and by 2000 over 60%. The installed nuclear capacity in 1980 will be about 350 gW of electricity, and in 2000 about 4300 gW. These figures may be compared with a total world electrical generating capacity of about 1100 gW in 1970. By 2000, North America and Western Europe will not be, as they are now, the "most nuclear" regions of the world. Throughout the world, most of the electrical capacity in use in 2000 will have been commissioned after 1980, and will be nuclear for the most part. The primary reason for this expected growth is economic. When all factors of environmental protection are taken into account, nuclear energy seems to offer the best chances of achieving lowest cost for generating units of 500 MW capacity. Units of this size, or larger, will be required throughout the world as societies become more technological. Reactor developments are discussed. Applications for nuclear power are described. 12 references. (auth)

45836 (GAMD-9911) POSTIRRADIATION EXAMINATION OF PEACH BOTTOM REFLECTOR ELEMENT B16-01 AFTER EXPOSURE TO 300 EFFECTIVE FULL POWER DAYS. Cobb, H. R. W. (Gulf General Atomic, Inc., San Diego, Calif.). 1 Feb 1970. Contract AT(04-3)-314. 34p. Dep. CFSTI.

The results of hot cell examination of a graphite side-reflector element after 300 effective full power days (EFPD) in a high-flux and high-temperature position in the Peach Bottom reactor are reported. No significant distortion was detected in this examination, which indicated that similarly positioned reflector elements at Peach Bottom could be used to fast fluences well beyond their intended life of 1350 EFPD. The reasons for the limited amount of axial distortion as well as the causes of the discrete areas of carbonaceous deposit observed on the surfaces of the element are discussed. (15 references) (auth)

45837 (ORNL-tr-2356) STUDY AND CONSTRUCTION OF THE PRESTRESSED CONCRETE VESSEL OF THE BUGEY I NUCLEAR POWER PLANT. Launay, P. Translated for Oak Ridge National Lab., Tenn., from Ann. Inst. Tech. Batiment Trav. Publics; 23: 71-107(1970). 75p. Dep. CFSTI.

The prestressed concrete caisson of the natural uranium fueled graphite-gas nuclear power station prototype characteristics are: The operating pressure is 45 bars for an inside diameter of the cylindrical cavity of 17.10 m. The upper slab has no transverse cabling because of the configuration of the standpipe unit which contains 950 shafts which leaves only a minimum of space between them. The studies begun in 1964 involved numerous tests and experimentations with two $\frac{1}{5}$-scale models. For the building of the caisson, the metal parts incorporated in the structure were prefabricated. The prestressing of the structure required the tensioning of nearly 4,500 tons of cables. A great number of measuring devices should make it possible to control the behaviour of the structures. (auth)

45838 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY CONFERENCE ON POWER REACTOR SYSTEMS AND COMPONENTS, SEPTEMBER 1-3, 1970, WILLIAMSBURG, VIRGINIA. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc.; 13: Suppl., 1-44(1970). (CONF-700904).

Included are summaries of papers on design, fabrication, performance, and inspection of power reactor components and systems. Each of the 47 papers summarized is title listed. (H.D.R.)

For abstracts of individual papers see: 45839-45856, 45988, 45989, 45998-46003, 46021-46026, 46029, 46036-46041, 46047, 46048, 46059, 46060, 46073, 46074, 46077, 46090, 46091, 46105, 46107, and 46125.

45839 IN-SERVICE INSPECTION PROGRAM FOR A PWR. Selig, B. J.; Hedden, O. F.; Kosky, R. P. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 13: Suppl., 1(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45840 IN-SERVICE INSPECTION OF NUCLEAR REACTOR VESSELS BY AN AUTOMATED ULTRASONIC METHOD. Gross, L. B.; Johnson, C. R. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 13: Suppl., 1-2(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45841 ARCHITECT-ENGINEER'S ROLE IN IN-SERVICE INSPECTION OF REACTOR COOLANT SYSTEMS. Foster, L. E. (Gilbert Associates, Inc., Reading, Pa.). Trans. Amer. Nucl. Soc.; 13: Suppl., 2(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45842 UTILITY QUALITY ASSURANCE EVOLUTION AT A TURNKEY. Grob, John J. Jr.; Corcoran, J. Andrew; Wasilenko, George (Consolidated Edison Co. of New York, Inc., New York). Trans. Amer. Nucl. Soc.; 13: Suppl., 3(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45843 PROPOSED INDUSTRIAL STANDARD FOR NUCLEAR PLANT QUALITY ASSURANCE PROGRAM REQUIREMENTS. Bernsen, S. A. (Bechtel Corp., San Francisco). Trans. Amer. Nucl. Soc.; 13: Suppl., 3-4(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45844 PREVENTION OF FAILURE. Norris, J. M. (Battelle Northwest Labs., Richland, Wash.); Jokela, W. V. Trans. Amer. Nucl. Soc.; 13: Suppl., 4-5(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45845 SAFETY RESEARCH AND DEVELOPMENT AND ITS RELATIONSHIP TO EMERGENCY CORE COOLING SYSTEM DESIGN. Carbiener, Wayne A. (Battelle Columbus Labs., Columbus, Ohio). Trans. Amer. Nucl. Soc.; 13: Suppl., 6(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45846 EQUIPMENT SUPPORT DESIGN FOR AN 800-MW(e) PWR STATION. VanSickel, A. L. (Stone and Webster Engineering Corp., Boston). Trans. Amer. Nucl. Soc.; 13: Suppl., 6-7 (1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45847 DYNAMIC EFFECTS ON PWR COMPONENT SUPPORTS RESULTING FROM PIPE RUPTURE. Dainora, John (Stone and Webster Engineering Corp., Boston). Trans. Amer. Nucl. Soc.; 13: Suppl., 7(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45848 EXPERIMENTAL BENDING TESTS ON PRESSURIZED PIPING UNDER STATIC AND SIMULATED ACCIDENT CONDITIONS. Fox, J. N.; Salvatori, R.; Thailer, H. J. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 13: Suppl., 8-10(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45849 RDT STANDARDS PROGRAM. Crawford, J. W. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 13: Suppl., 12(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45850 NUCLEAR POWER STANDARDS DEVELOPMENT IN IEEE. Russ, John C. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc.; 13: Suppl., 13(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45851 CURRENT STATUS AND PHILOSOPHY OF AEC REGULATORY STANDARDS DEVELOPMENT. Case, Edson G. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 13: Suppl., 13(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45852 INDUSTRY PARTICIPATION IN THE NUCLEAR STANDARDS PROGRAM. Joslin, Murray. Trans. Amer. Nucl. Soc.; 13: Suppl., 13(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45853 RADIOACTIVE FILTER HANDLING FACILITY DESIGN FOR PRAIRIE ISLAND NUCLEAR PLANT. Larsen, D. E. (Northern States Power Co., Minneapolis); Edelstein, J. Trans. Amer. Nucl. Soc.; 13: Suppl., 22-3(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45854 CONTAINMENT RESPONSE AND HEAT TRANSFER RESULTS FROM THE CAROLINAS-VIRGINIA TUBE REACTOR SIMULATED DESIGN BASIS ACCIDENT TESTS. Schmitt, R. C. (Idaho Nuclear Corp., Idaho Fall). Trans. Amer. Nucl. Soc.; 13: Suppl., 23-4(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45855 COOLANT ACTIVITY EXPERIENCES AT CONNECTICUT YANKEE. Hartley, F. W. (Connecticut Yankee Atomic Power Co., Hartford, Conn.). Trans. Amer. Nucl. Soc.; 13: Suppl., 29(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45856 FORT ST. VRAIN PCRV. Northrup, T. E.; Davis, D. E. (Gulf General Atomic, Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc.; 13: Suppl., 35-7(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45857 FUEL ELEMENTS IN GAS COOLED REACTORS. Thorn, James D.; Waddams, John A.; Winkenbach, Herbert. BBC-Nachr.; 52: 22-5(Jan-Feb 1970). (In German).

The core of the advanced gas-cooled reactor at Windscale, England consists of fuel elements that are composed of bundles of fuel rods. Depending on the thermal power of the reactor, the number of necessary fuel elements varies. Construction of fuel rods and their arrangement in fuel elements are described and depicted. Experience over several years with various types of fuel elements is described. (H.B.G.)

45858 NUCLEAR ENERGY IN THE UNITED STATES. Leclercq, Jean. Euro-Spectra; 9: 41-5(Jun 1970).

Predictions concerning nuclear power plant development in the U. S. are presented. Trends and uncertainties are analyzed. (D.C.C.)

45859 APPLICATIONS OF ATOMIC ENERGY IN AFRICAN ECONOMIC AND SOCIAL DEVELOPMENT PLANS. Lloyd, O. E. S. (International Atomic Energy Agency, Vienna). pp 9-25 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The basic principles of nuclear techniques are described as applied in: raw materials development, including resources inventory; power; food and agriculture, including preservation and conservation; industry; medicine and biology; water resources development; and education and training, including manpower resources. Situations and problems as they are to be found in individual African countries or sub-regions of the Continent are described. Relative priorities are presented. (auth)

45860 INTRODUCTION OF NUCLEAR POWER GENERATION IN DEVELOPING COUNTRIES. EXPERIENCE IN THE U. A. R. Zaazou, A. A. (Ministry of Electricity and High Dam, Cairo); Effat, K. E. A. pp 325-33 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

Progress in recent years in nuclear power technology has clearly defined the role which nuclear power stations can play in replacing conventional thermal power stations. The elaboration and implementation of a nuclear power program or project covering the whole of a developing country requires a thorough examination and correct evaluation of a number of different factors. The principal considerations involved in the introduction of nuclear power in the U.A.R. are reviewed. 12 references. (auth)

45861 MEASUREMENTS WITH RESPECT TO FUEL ELEMENT MONITORING IN THE RHEINSBERG NUCLEAR POWER PLANT REACTOR. Koehler, F.; Kaestner, R.; Mehner, H.-C. (VEB Kernkraftwerk, Rheinsberg, Ger. Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 13: 144-8 (May 1970). (In German).

Measurements on defect fuel element detection and localization have been made in the Rheinsberg nuclear power plant during refueling in August 1968. For this purpose, water samples have been taken from each working assembly and investigated by using a Ge(Li) semiconductor spectrometer. In the γ ray spectra of three assemblies a ^{133}I activity by about 10 times above mean value has been found. (auth)

Operation and Economics

Refer also to abstract 46100.

45862 (BARC-479) NUCLEAR POWER PROSPECTS IN THE MEKONG BASIN. Thomas, K. T.; Rajan, N. S. Sunder (Bhabha Atomic Research Centre, Bombay (India)). 1970. 25p. Dep. CFSTI (U. S. Sales Only).

The four lower Mekong countries, Thailand, Laos, Cambodia and the Republic of Vietnam that share the Mekong River—probably one of the largest natural resources in Southeast Asia—have common problems of development. Economy of these countries is mainly based on agriculture, the industrial base being very small. The per capita consumption of electricity, in this region in the year 1965 varied from a high of 46.0 kWh in Thailand to a low of about 6.1 kWh in Laos. These figures can be compared to 76.5 kWh in India and 4800 kWh in the United States during the same year. The main load center of power consumption in the region is located around Greater Bangkok in Thailand where there has been an upsurge in the development of industries in the recent past. Except for local transmission and distribution networks which are in existence, there are no interconnecting national or regional grids in the area. The status of electrical power development in the area, and a classified break-up of installed capacities are presented. The electrical power industry in the region is still in its initial stages of development. In particular, the bases of electrical power industry in Laos and Cambodia are very small and mainly dependent on diesel units of small capacities (5 to 10 MW). (auth)

45863 (BNL-50205, pp 33-4) EVALUATION AND TECHNICAL ASSISTANCE GROUP. Raseman, C. J. (Brookhaven National Lab., Upton, N. Y.).

Analysis of potential hydroelectric pumped storage power sources combined with nuclear power plant operations is presented. Operation and maintenance costs for nuclear power plants are analyzed. Codes and standards for power reactor construction and operation are reviewed. (D.C.C.)

45864 (CONF-700810-19) ROLE OF NUCLEAR POWER IN JAPAN. Ipponmatsu, Tamaki (Japan Atomic Power Co., Tokyo). [1970]. 11p. (SM-146/3). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Compared with fossil fuels such as coal and oil as sources of electric energy production, the nuclear portion in electricity is growing. With the comparatively rapid pace of technological development, large availability of resources, improving economics of power generation, and very importantly, because of easier position with regard to public acceptance problems, nuclear electric power has many things to its advantage. So-called proven-type power reactors, and especially those in the light-water family, seem to have a good and promising future for generations, and it is expected that breeders will break into the commercial market by 1990s. Power economics will be standing on firm ground during the current decade. Towards the end of the century, electric power will mark over 60% of the total energy consumed, and in Japan about 50% of that will be nuclear. (auth)

45865 (DOCKET-50133-36) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Operations Report, January–June 1970. (Pacific Gas and Electric Co., San Francisco, Calif.). 2 Sep 1970. 24p. Dep. CFSTI.

45866 (DOCKET-50155-47) BIG ROCK POINT NUCLEAR PLANT. Semiannual Report of Operations, November 1, 1969–June 30, 1970. (Consumers Power Co., Jackson, Mich.). 2 Sep 1970. 17p. Dep. CFSTI.

45867 (DOCKET-50206-57) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, May 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 15 Jun 1967. Contract AT(30-1)-3270. 5p. (NYO–3270-2). Dep. CFSTI.

45868 (DOCKET-50206-58) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, June 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 15 Jul 1967. Contract AT(30-1)-3270. 6p. (NYO–3270-3). Dep. CFSTI.

45869 (DOCKET-50206-59) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, July 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 17 Aug 1967. Contract AT(30-1)-3270. 7p. (NYO–3270-4). Dep. CFSTI.

45870 (DOCKET-50206-60) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, August 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 11 Sep 1967. Contract AT(30-1)-3270. 4p. (NYO–3270-5). Dep. CFSTI.

45871 (DOCKET-50206-61) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, September 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 9 Oct 1967. Contract AT(30-1)-3270. 5p. (NYO–3270-6). Dep. CFSTI.

45872 (DOCKET-50206-62) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, October 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 20 Nov 1967. Contract AT(30-1)-3270. 6p. (NYO–3270-7). Dep. CFSTI.

45873 (DOCKET-50206-63) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, November 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 11 Dec 1967. Contract AT(30-1)-3270. 6p. (NYO–3270-8). Dep. CFSTI.

45874 (DOCKET-50206-64) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, December 1967. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 15 Jan 1968. Contract AT(30-1)-3270. 6p. (NYO–3270-9). Dep. CFSTI.

45875 (DOCKET-50206-65) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, January 1968. (Southern California Edison Co., Los Angeles). 8 Feb 1968. Contract AT(30-1)-3270. 11p. (NYO–3270-10). Dep. CFSTI.

45876 (DOCKET-50206-66) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, February 1968. (Southern California Edison Co., Los Angeles.). Mar 1968. Contract AT(30-1)-3270. 9p. (NYO–3270-11). Dep. CFSTI.

45877 (DOCKET-50206-67) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, March 1968. (Southern California Edison Co., Los Angeles). Apr 1968. Contract AT(30-1)-3270. 8p. (NYO–3270-12). Dep. CFSTI.

45878 (DOCKET-50206-68) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, April 1968. (Southern California Edison Co., Los Angeles). May 1968. Contract AT(30-1)-3270. 6p. (NYO–3270-13). Dep. CFSTI.

45879 (DOCKET-50206-69) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, June 1968. (Southern California Edison Co., Los Angeles). Jul 1968. Contract AT(30-1)-3270. 5p. (NYO–3270-15). Dep. CFSTI.

45880 (DOCKET-50206-70) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, July 1968. (Southern California Edison Co., Los Angeles). Aug 1968. Contract AT(30-1)-3270. 6p. (NYO–3270-16). Dep. CFSTI.

45881 (DOCKET-50206-71) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, August 1968. (Southern California Edison Co., Los Angeles). Sep 1968. Contract AT(30-1)-3270. 8p. (NYO–3270-17). Dep. CFSTI.

45882 (DOCKET-50206-72) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, September 1968. (Southern California Edison Co., Los Angeles). Oct 1968. Contract AT(30-1)-3270. 10p. (NYO–3270-18). Dep. CFSTI.

45883 (DOCKET-50206-73) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, October 1968. (Southern California Edison Co., Los Angeles). Nov 1968. Contract AT(30-1)-3270. 8p. (NYO–3270-19). Dep. CFSTI.

45884 (DOCKET-50206-74) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, November 1968. (Southern California Edison Co., Los Angeles). Dec 1968. Contract AT(30-1)-3270. 7p. (NYO–3270-20). Dep. CFSTI.

45885 (DOCKET-50206-75) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, February 1969. (Southern California Edison Co., Los Angeles). Mar 1969. Contract AT(30-1)-3270. 6p. (NYO–3270-23). Dep. CFSTI.

45886 (DOCKET-50206-76) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, March 1969. (Southern California Edison Co., Los Angeles). Apr 1969. Contract AT(30-1)-3270. 7p. (NYO–3270-24). Dep. CFSTI.

45887 (DOCKET-50206-77) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, May 1969. (Southern California Edison Co., Los Angeles). Jun 1969. Contract AT(30-1)-3270. 4p. (NYO–3270-26). Dep. CFSTI.

45888 (DOCKET-50206-78) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, June 1969. (Southern California Edison Co., Los Angeles). Jun 1969. Contract AT(30-1)-3270. 8p. (NYO–3270-27). Dep. CFSTI.

45889 (DOCKET-50206-88) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Semiannual Operating Report No. 6, January 1–June 30, 1970. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 10 Jul 1970. 7p. Dep. CFSTI.

45890 (DOCKET-50237-68) DRESDEN NUCLEAR POWER STATION, UNIT 2. Semiannual Report, December 22, 1969–June 30, 1970. (Commonwealth Edison Co., Chicago, Ill.). 28 Aug 1970. 39p. Dep. CFSTI.

45891 (HPR–116) THEORETICAL ANALYSIS OF BURN-UP EXPERIMENTS WITH THE HBWR SECOND FUEL CHARGE. Ekberg, K.; Wennemo-Hanssen, S. E. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Feb 1970. 50p. Dep. CFSTI (U. S. Sales Only).

A series of in-pile and out-of-pile experiments to determine burnup characteristics was conducted in 1966 with the second fuel charge of the Halden Boiling Heavy Water Reactor. The experiments were performed in order to obtain results against which theoretical reactor physics models for heavy water lattices could be tested. The average burnup for the fuel at the time of the experiments was 5430 MWd/tU. The results of the theoretical analysis related to the above experiments are presented. The comparison of calculated and measured data comprises the following items: isotopic composition of the burned fuel; critical size of the core and reactivity coefficients at low power; and reactivity effects induced by power changes. The experimental and theoretical results for the burned fuel are compared with the corresponding results for the unburned core. 17 references. (auth)

45892 (NP–18384) PARA NUCLEAR POWER STATION. Technical and Economical Feasibility Study. (Minas Gerais Univ., Belo Horizonte (Brazil). Instituto de Pesquisas Radioativas). May 1968. 170p. Dep. CFSTI (U. S. Sales Only).

The approach of the feasibility study was twofold: on one hand, an economic appraisal of the problem was made, analyzing both the costs of isolated power stations, and the overall costs of long-range system expansion with different alternatives; on the other hand, an appraisal of the technical and administrative problems involved by the introduction of nuclear power was made: analysis of available reactors, preliminary selection of sites, and construction, operating and legal problems. Nuclear stations considered in the study were of two types, representing the extremes of the price structure spectrum. On one hand, there was the boiling water reactor considered as representative of the light water reactors price structure; on the other, there was the heavy water reactor (CANDU type). The detailed analysis of the system expansion is presented and contains the definite results of the study. A total of 204 alternatives were analyzed, including thermal (oil), nuclear, and hydro-stations. This showed that the introduction of a nuclear station of about 100 MW in 1973 (i.e., beginning construction in 1969) is not economically justified. The recommended solution for this first station is a thermal oil plant with two 25 MW units. From the technical point of view, there seems to be no special problem in constructing the nuclear station. The legal aspects of the problem were also carefully analyzed. There is no direct legal obstacle to the project, as the basic legal structure of nuclear power exists in Brazil. However, many points of detail, like codes and rules, remain to be elaborated, thus complicating the administrative procedure of constructing this plant which would be Brazil's first nuclear station. (auth)

45893 (TID-25495) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, May 1970. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 15 Jun 1970. 54p. (In German). Dep. CFSTI.

During May all preparations for the planned shut-down from 30 May to 12 July 1970 were completed. On 3 May 1970 preheater No. I had to be taken out of service because of a leak in one of the bled-steam lines. A training program for the shift personnel was carried out before the shut-down, reducing the reactor power three times to about 200 MW(t) and disconnecting the turbogenerator from the grid for a few hours. This program also enabled a check on the service ability of all plant components. Neither the waste-gas activity nor the specific activity in the primary water showed any appreciable rise even after these considerable and sometimes sudden power changes. On 30 May 1970 the plant was run down and during the cooling period the temperature coefficient and hydrogen production in the hours immediately following the reactor scram were measured. (auth)

45894 BETRIEB VON KERNKRAFTWERKEN. (Operation of Nuclear Power Stations). Weckesser, August. Thiemig-Taschenbuecher, Band 37. Munich; Verlag Karl Thiemig KG (1969). 180p. DM 14.80. (NP-18334).

The first generation of nuclear power stations comprising boiling water reactors, pressurized water reactors, and gas-cooled reactors are discussed. Construction of the plant from the standpoint of the operator is analyzed as to primary circuit, secondary circuit, and total composition. All phases of startup operation are described; preparatory measures, criticality experiments, power phase, and operation of conventional components are also included. Power operation is treated as to startup, power change, long-term performance, fuel service, chemistry, radiation protection and monitoring. (H.B.G.)

45895 SPAIN'S NUCLEAR POWER PROGRAM. Com. Naz. Energ. Nucl., Notiz.; 16: No. 5, 89-93(May 1970). (In Italian).

A picture of the situation of nuclear power plants in Spain is presented. Economic and technical information is supplied concerning the main plants at present in operation, under construction or planned. (auth)

45896 ENERGY CONSUMPTION: ITS GROWTH AND PATTERN. Merlin, H. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Can. Inst. Mining Met.; 72: 136-45(1969).

The past demands for energy and the contributions by the major sources are shown for the world and regions, and for Canada. Three forecasts of future demand are presented. By the year 2000, the world will be consuming energy at a rate of $670-700 \times 10^{15}$ Btu/year. Canada's rate is estimated at 20×10^{15} Btu/year. Electricity will increase its portion of energy from 7.5% to 15%, and more than 40% of the primary energy will be required to generate it. World, regional and Canadian forecasts are given for total electricity generated and for electricity generated in nuclear stations. The integral world requirement for energy by the year 2000 will be over 12×10^{18} Btu. Current recoverable fossil and hydro reserves are about 18×10^{18} Btu. The total reserves are estimated to be seven times greater. World production of electricity in nuclear stations by the year 2000 will be almost three times the electricity produced in the world today. The amount of fuel consumed in generating this electricity will depend upon the types and mix of reactors installed. The heavy water reactors, alone or in conjunction with fast breeders and liquid fuel reactors, are the most efficient users of uranium and thorium resources. The heavy water reactors are also the most efficient producers of plutonium which will be required as fuel for fast breeders. (auth)

45897 OPERATIONAL EXPERIENCE WITH THE BOILING WATER REACTOR OF THE LINGEN NUCLEAR POWER PLANT. Schulze, J. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech.; 15: 396-8(Aug 1970). (In German).

The Lingen nuclear power plant has been in commercial operation since October 1, 1968. Because of its excellent controllability, it was not only used for permanent full power production but also for compensation of fluctuations in the general power grid. During the first one and one half years of operation, the reactor was utilized approximately 86.5%; duration of criticality was 93.8%. The first fuel cycle ended in June 1970. For optimal efficiency, certain changes in the control rods were made so that optimal distribution of power could be achieved throughout the reactor core. (tr-auth)

45898 EXPANSION PROSPECTS OF NUCLEAR POWER STATIONS IN ITALY. Angelini, Arnaldo M. pp 21-69 of Italian Nuclear Industry. Rome; C.A.P. (1969). (In several languages).

The development of nuclear power plants in Italy is described. Lists of worldwide nuclear power plants now operating or under construction are included. (D.C.C.)

Safety and Siting

Refer also to abstracts 44093 and 45847.

45899 (CONF-700810-1) ECOLOGICAL CONSIDERATIONS IN REACTOR POWER PLANT SITING. Auerbach, S. I.; Nelson, D. J.; Kaye, S. V.; Reichle, D. E.; Coutant, C. C. (Oak Ridge National Lab., Tenn.). [1970]. 18p. (SM-146/53). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Four ecological considerations which bear on the location of nuclear power plants are discussed. The considerations include: long-term effects of the released radionuclides on the environment, especially on maintenance of the ecological balance; environmental fate of radionuclides, including their food-chain dynamics and potential to build-up at different ecological levels; ecological pathways by which radionuclides may expose human population groups; and influences of the discharge of waste heat into the aquatic environment. (47 references) (auth)

45900 (CONF-700810-4) ENVIRONMENTAL MONITORING FOR U. S. LICENSED POWER REACTORS. Beck, Clifford K. (Atomic Energy Commission, Washington, D. C.). [1970]. 21p. (SM-146/54). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The regulatory staff of the AEC establishes through its regulations and in the unique conditions included in each licence for a nuclear power reactor, the routine effluents permitted from each reactor and the monitoring requirements the licensee must carry out on effluent streams and in environmental surveillance. The required scope of environmental monitoring around facilities varies over a considerable range depending on the level of effluents with respect to the maximum levels permitted; the lower the level of effluents the nearer the monitoring programme may be to the minimum level defined. Uniform procedures and format have been developed for the periodic reporting of effluents and environmental monitoring data by licensees. The overall monitoring requirements of licensed plants are described in some detail, along with tabulations of reactor effluent tabulations thus far recorded. (7 references) (auth)

45901 (CONF-700810-8) STANDARDS FOR EFFLUENTS IN SWITZERLAND. Courvoisier, P. (Federal Office of Energy, Wuerenlingen (Switzerland)); Mueller, B. (Federal Office of Water Protection, Bern (Switzerland)). [1968]. 15p. (SM-146/14). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Maximum permissible levels for the release of effluents are stated by different laws, ordinances, or guidelines in Switzerland. Policies followed will be outlined. A recent addition of general interest is the recommendation of limits for thermal pollution. As the production of electric energy in Switzerland has been until

very recently nearly exclusively by hydroelectric plants, the natural régime of the rivers has not been changed to any appreciable extent by their use as receivers of cooling water. It is possible, therefore, to use the rivers for the direct cooling of a first group of nuclear power stations. However, the permissible limits for this use of river water had to be identified and fixed in the light of the goals for water protection stated by the Swiss law. An extensive study was made to this end which will be reported briefly. The results of it will be compared to other studies on the same subject which have appeared since the publication of the Swiss study. This study has demonstrated the need to set up careful planning for the disposal of heat in rivers. (auth)

45902 (CONF-700810-9) SITING OF NUCLEAR POWER STATIONS IN SWITZERLAND. Courvoisier, P. (Federal Office of Energy, Wuerenlingen (Switzerland)). [nd]. 11p. (SM-146/39). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The topographical situation in Switzerland leads to a concentration of the general population in the valleys of the larger rivers Nuclear power stations tend to be built in the same valleys for reasons of provision of cooling water. Hence, sites with very low population density cannot be expected in Switzerland. It follows that questions of travel and dispersion in valleys of radioactive off-gases from nuclear power plants have to be considered. Studies on this subject are reported. It follows furthermore that measures to protect the ground-water streams in the river valleys are of great importance. Criteria for measures are given. However, the protection of the plants against detrimental actions of the ground water has to be considered too. The existence of hydroelectric plants in the valleys poses a risk of inundations which has to be considered in the safety analysis of nuclear power plants. Studies on this question are touched upon. Another influence of exterior origin which could affect a nuclear power station is the crashing of a large airplane. After a recent crash close to a Swiss nuclear power station this question was considered once more and is reported on. The increased rigidity of buildings which had been called for by seismic considerations has improved their stability against airplane crashes. It is possible to use rivers for the direct cooling of a first group of nuclear power stations. The permissible limits for this use had to be identified and fixed. Public opposition was recently felt mainly with regard to the problems of thermal pollution, but general concern over the dangers of nuclear energy is expressed to some degree as well. The situation regarding public opinion is reported. (auth)

45903 (CONF-700810-11) REVIEW OF U. S. POWER REACTOR OPERATING EXPERIENCE. Eisenbud, Merril (New York Univ., N. Y. Medical Center). [1970]. 34p. (SM-146/55).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Fifteen nuclear power plants have supplied civilian electric power in the United States, and more than eighty nuclear power generators are under design or construction. When completed in the mid 1970s, these will generate about 70,000 megawatts or about 14% of the expected national demand. The accumulated environmental experience of the nuclear power industry is reviewed. The gaseous, liquid, and solid radioactive wastes are summarized and their significance is evaluated from the point of view of human and ecological effects. The data are discussed in relation to effluents from combustion of fossil fuels. 19 references. (auth)

45904 (CONF-700810-13) POLICY ALTERNATIVES FOR RESOLVING THE POWER PLANT SITING PROBLEM. Freeman, S. David; Weinhold, J. Frederick (Office of Science and Technology, Washington, D. C.). [nd]. 12p. (SM-146/34).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The conflict between the increasing demand for electric power in the United States and the need to preserve the environment is encountered whenever a major new power plant or high-voltage transmission line is planned and built. The general directions in which power plant siting and transmission line routing policies will move during the next several years are analyzed. The general topics reviewed include long-range planning, institutional arrangements for preconstruction approval of individual facilities, acquisition of power plant sites, research and development ideas, and the high growth rate being experienced by the electric power industry. (auth)

45905 (CONF-700810-14) ENVIRONMENTAL QUALITY PROTECTION: LARGE STEAM-ELECTRIC POWER STATIONS. Gartrell, F. E.; Stone, G. F.; Wojtalik, T. A. (Tennessee Valley Authority, Chattanooga. Div. of Environmental Research and Development). [1970]. 33p. (SM-146/28).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Since the early fifties, as a part of its coal-fired steam plant operations, TVA has carried out comprehensive air and water quality programs to appraise environmental aspects. To appraise the effects of a large multi-unit nuclear plant on total environment, TVA is planning comprehensive and integrated environmental monitoring programs. Already under way at the Browns Ferry Nuclear Plant being built in north Alabama are studies to document levels of natural and man-made radioactivity in air, soil, vegetation, water and aquatic life to establish base-line data some two years before plant start-up. Similar studies are being conducted in Wheeler Reservoir to document pre-start-up stream temperatures and to obtain data on fish populations and other related aquatic organisms. To obtain much-needed quantitative and qualitative information on the potential effects of heated water discharges on aquatic life, TVA and the Federal Water Quality Administration are planning a special research station adjacent to the Browns Ferry plant. The basic elements of this station involve eight simulated naturalistic stream channels, each 14 feet wide and 390 feet long, with provisions for maintaining desired controlled temperature in the waters flowing through them. The planned operation of these channels for detailed studies of heat effects on the spawning, egg fertilization, egg and larvae development, and growth of warm-water fish is described; and the integrated approach being taken by TVA to protect total environmental quality at all of its large thermal plants is presented. 11 references. (auth)

45906 (CONF-700810-15) REGIONAL ENVIRONMENTAL CONSIDERATIONS IN THE EVOLUTION OF AND OPERATING EXPERIENCE WITH THE SOUTHERN CALIFORNIA EDISON COMPANY GENERATING SYSTEM. Gould, William R.; Moore, J. B. (Southern California Edison Co., Los Angeles). [1970]. 13p. (SM-146/44).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

As a result of the ever continuing growth of population and industry in the Los Angeles Air Basin, an area of restricted air replenishment with the majority of potable water imported, environmental factors have strongly affected both design of generating equipment and its siting. Programs to retain air quality in the area and restrictions placed on power plants are reviewed. The development of nuclear power plants is described. Predictions for future replacement of present steam power plants with nuclear power plants are presented. (9 references) (auth)

45907 (CONF-700810-18) POWER STATION SITE SELECTION IN ENGLAND AND WALES. Hunt, F. R. (Central Electricity Generating Board, London (England)). [nd]. 15p. (SM-146/35). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The policy which has been followed in recent years in England and Wales of siting power plants for optimum convenience and economics is described. The first generation of nuclear stations were with one exception sited on the coast partly because of the Government's remote-siting policy and partly because of the relatively large cooling water requirements of the Magnox reactors. The extent to which partial relaxation of the remote-siting policy and the reduced cooling water requirements of advanced gas-cooled reactors encourage inland siting of some nuclear stations using cooling towers is discussed. The factors taken into account in selecting a site for a power station are considered and the measures taken in the siting and design of direct cooled stations to ensure that the warm water discharge does not cause adverse environmental effects are described. In the clean air field the advantages of dispersing boiler flue gases from the minimum number of very tall chimneys are noted. The importance of monitoring the effect on the environment of gaseous and liquid discharges from fossil-fuel and nuclear stations to ensure that design expectations are achieved in practice is emphasized. The steps taken to make power stations as acceptable as possible to the public are discussed—leading architects and landscape consultants being engaged to advise on site layout, orientation and shapes of structures, use of color, land contouring and tree planting. (auth)

45908 (CONF-700810-20) AN APPROACH TO COMPARE AIR POLLUTION OF FOSSIL AND NUCLEAR POWER PLANTS. Jansen, P.; Jordan, S.; Schikarski, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). [1969]. 18p. (SM-146/57). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The possible air pollution of fossil and nuclear power plants is discussed. Since the emissions of fossil and nuclear power plants are different in nature and effect on the environment, the comparison of the air pollution of power plants is difficult. This is mainly due to the fact that fossil power plants pollute air by the emission of reactive gases (i.e., sulphur oxides) and smoke (aerosols) whereas nuclear power plants could emit radioactive gases (i.e., fission gases) and radioactive aerosols which affect the environment in a different way. A study has been carried out to compare air pollution of both nuclear and fossil fuelled power plants. Two models have been used in the study. The first was developed on the basis of the maximum permissible concentrations set by biophysical and medical bodies for the various pollutants. The second model used the fact that excessive burdens by the various pollutants to the surrounding population lead statistically to a certain number of cases of illness or death. Both methods showed the importance of population density. A detailed explanation of the calculational procedure is discussed. Results on German power plants are reported. (auth)

45909 (CONF-700810–22) ENVIRONMENTAL BEHAVIOUR OF DISCHARGED RADIOACTIVE EFFLUENTS AT TARAPUR ATOMIC POWER STATION. Kamath, P. R.; Bhat, I. S.; Ganguly, A. K. (Bhabha Atomic Research Centre, Bombay (India). Health Physics Div.). [1969]. 38p. (SM–146/58). Dep. CFSTI (U. S. Sales Only).

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During the preoperational, commissioning and operational phases of the station, studies were carried out in the near-shore waters to assess the effects of radioactivity discharges on shoreline contamination and the distribution of activity in the near-shore marine life forms. Radioiodine has so far been observed to be the most dominant airborne and waterborne contaminant, though the concentrations observed are well below the permissible limits for the media. On the basis of demographic survey of living and food habits of the population, the fishermen have been identified as the critical group in the Tarapur environment. Dyes, floats and radioactivities discharged from the station were used for tracing the movement of shoreline waters. There is evidence now from these field studies that there is considerable oscillation of near-shore waters leading to recirculation of the condenser discharges and radioactivity is observed to be building up in the near-shore sediments. Silt load in the near-shore waters is found to be efficient in scavenging down a number of radionuclides. Future trends of buildup in the environment are projected from environmental observations made up to 10 to 16 km along the shoreline in the eighteen months of operation and these results are compared with the anticipations made in the four years of preoperational environmental survey programs. Data are presented on naturally occurring vegetation and farm animals well suited for monitoring reactor fallout in the agricultural area. Some indicator organisms in the sea have been identified for specificity of uptake of activation products released with the reactor effluents. Limiting capacity of the near-shore environment as recipient of radioactive effluents and possible remedial and control measures to minimize radiation exposure to population from accidental release of effluents are indicated. A brief review of the environmental survey program at Tarapur is made, to indicate as to how the program is oriented to meet the consequences of different operating conditions of the station. (auth)

45910 (CONF-700810–23) EFFLUENT CONTROL FROM BOILING-WATER REACTORS. Kent, C. E.; Levy, S.; Smith, J. M. (General Electric Co., San Jose, Calif.). [1970]. 14p. (SM–146/21).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Over a decade of operating experience is available for reference from commercial boiling-water reactor nuclear power plants. Planned releases of radioactive materials to the environment have been based on a conservative design objective. Off-plant radiation doses are very small compared to permissible or natural background dose. The sources of wastes from the various portions of the plant are classified by physical and radioactive characteristics. Treatment processes are provided accordingly. The objective is to process and recycle these streams so as to minimize both volume and radioactivity of effluents. Releases to environs are controlled by batch processing and/or continuous monitoring before release so as to assure that no unplanned emission will actually occur. Monitoring in the environs of the facility is performed, starting prior to plant operation, as an audit on effluent controls and to provide data from which dose to the general public may be determined. Experience with existing plants indicates a high degree of conformance to the design objective. Development is continuing on systems and on operating methods to provide assurance that dose to the public is insignificant compared to natural background and the permissible dose rates. (auth)

45911 (CONF-700810–24) RADIOACTIVITY FROM FOSSIL FUEL AND NUCLEAR POWER PLANTS. Martin, J. E.; Harward, E. D.; Smith, J. M.; Bedrosian, P. H. (Bureau of Radiological Health, Rockville, Md. Div. of Environmental Radiation). [1969]. 14p. (SM–146/19).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Trace quantities of uranium and thorium and their products of radioactive decay are released in fly ash from large, fossil-fueled steam electric stations raising the question of the significance of these releases compared with those from nuclear power plants. Data relative to this question that were obtained from studies conducted by the Bureau of Radiological Health at operating coal- and oil-fired steam stations and at nuclear power plants are presented. The plants were compared by measuring or estimating exposure dose rates and calculating the fractions of the respective ICRP recommended limits they represented. When these fractions are related on a per-megawatt-electrical basis, it is found that the noble gases from a boiling-water reactor could produce more radiation exposure than the natural radioactivity emitted from the older, less efficient coal plant that was studied; however, for a pressurized water reactor the reverse is true. Comparisons are also made between coal-fired and nuclear power plants of current design to show the effects modern technology has on the relative radiological significance of each. The relative long-range effects of power plant fuel use are considered relative to the buildup of ^{85}Kr in the atmosphere and the release of carbon which is free of ^{14}C from fossil fuel plants. When this consideration was made, it was concluded that nuclear power reactors over the long term represent a greater overall radiological burden on the environment than fossil fuel plants, although all are well below radiation protection guides established by the U. S. Federal Radiation Council. 17 references. (auth)

45912 (CONF-700810–26) DOES INDUSTRIAL CALEFACTION JEOPARDIZE THE ECOSYSTEM OF A LONG TIDAL RIVER. Merriman, Daniel (Yale Univ., New Haven, Conn.). [1970]. 33p. (SM–146/31).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The Connecticut River, largest in New England, originates on the Canadian border of New Hampshire and empties into Long Island Sound. Its lower third (ca. 215 km) now provides sites for five fossil- and two nuclear-fueled electric generating stations whose combined nameplate rating is 2155 megawatts. Furthest downstream is the Connecticut Yankee Atomic Power Company (600 MW(e)) at Haddam, Ct., 25 km from the river mouth. It, like two fossil-fueled plants upstream but below Hartford, Ct., is within tidal influence (0.3–0.75 m) although above the salinity extinction point. A condition of the construction permit granted Connecticut Yankee 21 October 1964 by the State Water Resources Commission has required the Company to support a "thorough and comprehensive study of the river conditions and environment" since 1965. The preoperative phase of the study while the plant was being built (1965–1967) provides a clear basis for comparison with the operative phase (1968 to the present) when the calefacient or thermal effluent was being discharged into the river at a temperature 12.4°C above that at intake at a rate of 2.35×10^4 l/sec (over 1400 m^3/min). The study includes: the physical and chemical characteristics of the river and warm-water plume, microbiology, benthic fauna, resident fishes, and anadromous species; an environmental radiation monitoring programme is also conducted under Company auspices. To date no drastic effects have appeared. The most apparent changes have been: a shift in dominance at the outfall of the canal from diatoms to blue-green algae, alterations in the index of diversity and population size of the benthic fauna near the intake and outfall, and the strong attraction into the 1.8-km-long discharge canal during colder months of catfish spp. which undergo marked marasmus in the overcrowded and heated effluent. These conclusions are based on short-term observations and fail to take into account, subtle, long-term effects which are not now predictable as well as possible cumulative consequences of the operation of the upstream stations. (45 references) (auth)

45913 (CONF-700810–27) STATUS ON SITE SELECTION PROBLEM FOR NUCLEAR POWER STATION IN JAPAN. Miyake, S. (Federation of Electric Power Companies, Tokyo (Japan)); Hasumi, K. (Chubu Electric Power Co., Nagoya (Japan)). [1969]. 17p. (SM–146/38). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

In site selection, particular emphasis is placed on technical

consideration of the following three aspects: (1) The availability of cooling water. As in the case of conventional thermal power stations, the practice is to site Japanese nuclear power stations on the sea coast. (2) A low population density in the surrounding area. (3) Soundness of the subsurface conditions, in view of the antiseismic requirements peculiar to Japan. Owing to the geographical and geological factors governing the situation in Japan, sites satisfying all the necessary conditions are not numerous and also tend to be concentrated in a few areas. Even when a site is satisfactory, there are cases of difficulty in securing its acceptance by the local industry or population. Thus, in selecting a site and installing the station, particular attention must be given to the preparatory measures required, especially in connection with local problems. (auth)

45914 (CONF-700810-28) CRITERIA FOR THE CONTROL OF RADIOACTIVE EFFLUENTS. Morgan, K. Z.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). [1970]. 46p. (SM-146/10). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Some uniformity in regulating radioactive effluents from reactor power plants is highly desirable. Several approaches have evolved which fall short of providing information needed for realistic assessments of effluent hazard and the application of radiation protection guidelines oftentimes is superficial or mistaken. Failure to move towards uniformity in this area endangers both optimum development of nuclear energy and protection of the public health. Factors are discussed that have a significant bearing on efficacy of the assessments, including: description of released radioactive material; environmental pathways; bioenvironmental behaviour of released radionuclides; population distribution, habits and characteristics; radiation dosimetry applications; primary standards; dose apportionment; and dose criteria for reactor effluents. (28 references) (auth)

45915 (CONF-700810-30) THERMAL EFFECTS AND NUCLEAR POWER STATIONS IN THE U.S.A. Miller, D.; Tokar, J. V. (Argonne National Lab., Ill.); Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. 15p. (SM-146/30). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Steam-electric stations discharging heated condenser cooling water into public waters will modify the aquatic environment. There is no question that some changes will occur, but the biological problem is to determine the degree of changes, both short term and long term, the extent of these changes, and to determine if they significantly affect water uses. Because increasing power demands require operation of more power stations, utilities, federal and state agencies, universities, and various research organizations are expanding their thermal effects research. Published and unpublished research reports were reviewed to help identify the critical hydro-environmental problems. Pressing biological problems are identified and needed research and development are recommended. The state of the art of predicting temperature distributions resulting from steam-electric power station condenser cooling water discharges is discussed with emphasis on the different characteristics associated with sites on rivers, cooling ponds, lakes and estuaries. The overall design and verification of predictions is broken into three interacting types of study. These are analytical techniques, physical scale models and experimental field measurements. Problems specific to each of these areas and details of their interactions are reviewed, recommendations made, and areas for future study are indicated. (21 references) (auth)

45916 (CONF-700810-31) CONTROL OF ENVIRONMENTAL RADIOACTIVITY AT NUCLEAR POWER STATIONS. Pellerin, P. (Service Central de Protection Contre les Rayonnements Ionisants, Le Vesinet (France)). [1970]. 12p. (In French). (SM-146/24). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The control of environmental radioactivity at nuclear power stations is effected in several stages. Prior to the installation of a particular type of reactor a very thorough study of the site should first of all be effected, covering geological and ecological data. When the installation is complete routine monitoring should be carried out on all types of effluent at their point of discharge to the environment and at the same time on the different components of that environment (air, water, food chain, etc.). If necessary critical groups in the local population should be identified and the path of any critical radionuclides established. Finally, the overall picture thus obtained should be used for a periodical reevaluation of the situation with a view to making any necessary changes. Such evaluations should include a study of the possible consequences of nuclear incidents and accidents. (auth)

45917 (CONF-700810-32) THERMAL EFFECTS STUDIES IN NEW YORK STATE. Philbin, Thomas W. (Stoller (S. M.) Associates, New York); Philipp, Howard D. (Niagara Mohawk Power Corp., [Syracuse, N. Y.]). [1969]. 15p. (SM-146/32).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The thermal effects studies being carried out in New York State by the member companies of ESADA are described. The studies themselves generally fall into two categories. One is the prediction of temperature profiles around cooling water discharges; this is accomplished by model studies, aerial surveys, calculational methods, and measurement of existing discharges that are similar to the one under consideration. The principal benefits of this type of study have been in providing data for design of the actual discharge in compliance with state criteria, and in estimating possible effects on aquatic life. The second category covers the ecology of the body of water to be used for cooling. This involves observations of fish populations by netting and use of a unique hyperfine fathometer device, sampling of various forms of other aquatic species, and chemical and hydrological measurements. These studies have been performed preoperationally at specific sites and on some existing discharges. The data will be used principally as the base line for comparisons with postoperational surveys which are usually repeats of the preoperational ecological work. 10 references. (auth)

45918 (CONF-700810-34) ENVIRONMENTAL CONSIDERATIONS IN THE REGULATORY PROCESS FOR NUCLEAR POWER PLANTS IN THE U.S.: THE ROLE OF THE PUBLIC AND PUBLIC UNDERSTANDING. Ramey, J. T. (Atomic Energy Commission, Washington, D. C.). [1969]. 25p. (SM-146/5). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The role of the public in the licensing and regulation of nuclear electric power plants in the United States is analyzed. The development of the AEC's regulatory system providing for increasing public information and involvement is traced. The principal functions involved in nuclear power regulation, rule-making and licensing, and the ways in which the public participates are described. The public hearing is emphasized. Steps to further improve meaningful and timely public participation are discussed, with emphasis on resolution of environmental problems. Recent environmental legislation and its effect on AEC regulatory activities are also described. Means of enhancing public understanding of nuclear power and providing a sound basis for public confidence are considered. 29 references. (auth)

45919 (CONF-700810-35) METROPOLITAN SITING OF NUCLEAR POWER PLANTS. Cahill, W. J. Jr.; Hauspurg, A.; Roddis, L. H. Jr.; Wall, W. E. (Consolidated Edison Co. of New York, Inc., New York). [nd]. 20p. (SM-146/43).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The case for and against metropolitan siting of nuclear plants is analyzed, using as a model the New York City area. The economic benefits of proximity to load center are explored with respect to transmission costs and to opportunities for waste-heat utilization in urban areas. The relative environmental impact of nuclear and fossil plants is evaluated. How a metropolitan site presents unique advantages and disadvantages with respect to geological, meteorological and hydrological criteria for siting nuclear plants is examined. The special precautions needed to reduce risk to a level which it is postulated that the public (through the institution of government) would accept are discussed. The costs of these precautions are related back to the "discounted" cost advantage of load-center proximity for a plant of given size. The result is an assessment of the economic feasibility of metropolitan siting in today's climate of public understanding (and misunderstanding) about radiation risks and effects. (auth)

45920 (CONF-700810-36) U. S. REGULATIONS FOR THE CONTROL OF RELEASES OF RADIOACTIVITY TO THE ENVIRONMENT IN EFFLUENTS FROM NUCLEAR FACILITIES. Rogers, Lester; Gamertsfelder, Carl C. (Division of Radiation Protection Standards (AEC), Washington, D. C.). [1968]. 24p. (SM-146/8). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Releases of radioactivity in air and water effluents from nuclear facilities are regulated under the provisions of the Atomic Energy Commission's regulations, Parts 20 and 50. The basic considerations in translating into regulatory limits the radiation protection

guides recommended by the Federal Radiation Council (FRC) and approved by the President, the recommendations of the National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP) are described. Limits on concentrations and/or quantities of radioactivity that may be released in effluents from nuclear facilities and how these limits are applied to take into account all important pathways of exposure so as to assure that exposures to the public remain well within FRC radiation protection guides are discussed. Operating experience is reviewed which shows that radioactivity in water and air effluents from nuclear power reactors has generally been less than a few per cent of the limits specified in Part 20 and exposures to the public in the immediate vicinity of operating power reactors have usually been small fractions of FRC guides. Recent proposed amendments to the Commission's regulations in Parts 20 and 50 to improve the regulatory framework for assuring that reasonable efforts are made to keep exposures to radiation and releases of radioactivity in effluents as low as practicable, consistent with FRC guidance, are discussed. (auth)

45921 (CONF-700810–37) ENVIRONMENT: A GLOBAL PROBLEM, AN INTERNATIONAL CHALLENGE. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). 10 Aug 1970. 8p. Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The effects of worldwide power requirements on the environment are discussed. Problems related to future power demands are analyzed. (D.C.C.)

45922 (CONF-700810–40) ATMOSPHERIC CONTAMINATION OF INDUSTRIAL AREAS INCLUDING FOSSIL-FUEL POWER STATIONS AND A METHOD OF EVALUATING POSSIBLE EFFECT ON INHABITANTS. Tsunetoshi, Yoshizo; Ueda, Miyoko; Takahashi, Hisao; (and others) (Center for Adult Diseases, Osaka (Japan)). [1970]. 39p. (SM–146/16). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

In order to evaluate the effect of air pollution on human health and to provide for future pollution control plans, an investigation was conducted by Osaka Prefectural Government for five years beginning in 1964. The results of this investigation of the effect of air pollution on human health (prevalence of chronic bronchitis in a defined district as an effect of SO_2 contamination) are presented. (auth)

45923 (CONF-700810–42) ENVIRONMENTAL CONSIDERATIONS AND PUBLIC ACCEPTANCE ASPECTS OF NUCLEAR PLANT SITE SELECTION IN COASTAL AREA IN JAPAN. Saiki, M.; Koyanagi, T.; Ohmomo, Y.; Uchiyama, M. (National Inst. of Radiological Sciences, Chiba (Japan)). [1969]. 27p. (SM–146/41). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The policy concerning the discharge of liquid waste, of low-level activity, into coastal areas is described. Site requirements for reactors are reviewed. (auth)

45924 (CONF-700810–43) PUBLIC OPPOSITION TO NUCLEAR POWER: AN INDUSTRY OVERVIEW. Slater, Harry G. (Atomic Industrial Forum, Inc., New York, Niagara Mohawk Power Corp., Syracuse, N. Y.). [nd]. 15p. (SM–146/40).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The history, nature and scope of public opposition to nuclear power development in the United States, which has now been swept up in the broader concerns over the environment, are reviewed. Public issues relating to radiation standards, thermal effects, radioactive waste management, government indemnity, and the multiple functions of the United States Atomic Energy Commission are discussed. Ecological research programs of industries and many other collective efforts to maintain the environment are outlined. Various legislative reactions to the public's concern and the industrial impact of recent legislation are analyzed. (auth)

45925 (CONF-700810–47) BENEFIT-COST RELATIONSHIPS IN SOCIO-TECHNICAL SYSTEMS. Starr, Chauncey (California Univ., Los Angeles. School of Engineering and Applied Science). [nd]. 29p. (SM–146/47).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

An approach for establishing a quantitative measure of trade-offs between public safety and technology is presented. The analysis is based on two assumptions. The first is that historical records are adequate for revealing consistent attitudes on safety in the public use of technology. The second assumption is that such historically revealed social attitudes are sufficiently enduring to permit their use for predictive purposes. Many aspects of modern life are analyzed from the viewpoint of these two assumptions, as a basis for developing generalized concepts. Possible hazards from nuclear power plants are considered. (auth)

45926 (CONF-700810–48) THE SELECTION OF A SITE FOR THE FIRST NUCLEAR POWER STATION IN MEXICO. Velez, C. (Comision Federal de Electricidad, Mexico City). [1970]. 15p. (In Spanish). (SM–146/56). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The procedure for selecting a site for the first Mexican nuclear power station is described. 6 references. (auth)

45927 (CONF-700810–49) ENGINEERING SAFETY FACTORS AND THEIR INFLUENCE OF SITING PRACTICES FOR NUCLEAR POWER PLANTS IN THE EUROPEAN COMMUNITIES. Vinck, W. F.; Maurer, H. A.; Leonardini, L. (European Communities, Luxembourg. Commission). [1967]. 40p. (SM–146/37). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The nuclear power plants installed or under construction in the European Community are discussed. The limits on radioactive effluents permitted by the safety assessors in normal as well as in abnormal situations and the differences in allowances depending on the sites chosen and on the stage of development of protection devices and engineered safeguard systems available (filtering equipment and storage facilities) are examined. Mention is made of the problem of cooling capabilities and its influence on site selection. The main attention is dedicated to the discussion of abnormal and accidental situations, of which the loss of coolant accident is treated as a significant example. Preventive and mitigating means (engineered safeguards) installed in recent European nuclear power plants are dealt with. Emphasis is placed on the importance of meeting high efficiency and reliability when they are called upon. The possibility of improving systems design by comparative reliability analysis is discussed. Emphasis is placed on specific problems of containment and reactor pressure vessel design, the safety factors considered in the design of these components and their influence on siting practices. Information is finally given on site conditions, distance zones, population centers and densities of some important nuclear power plants in Europe, most of which are installed or planned in highly populated areas. (auth)

45928 (CONF-700810–51) IMPACT OF ENVIRONMENTAL RADIATION AND DISCHARGE HEAT FROM NUCLEAR POWER PLANTS. Wright, J. H.; Champlin, J. B. F.; Davis, O. H. (Westinghouse Electric Corp., Pittsburgh, Pa. Environmental Systems Dept.). [1970]. 21p. (SM–146/20). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The management of radioactive wastes from pressurized water reactors is reviewed both on the basis of design and experience to date. The radiation released from these operating power plants is used to estimate incremental environmental exposures occurring from such nearby plants. The waste management of tritium and its resulting environmental concentrations and possible impacts are in part the result of fuel cladding material, in part operating procedures, and in part waste disposal processes. Ways and means of altering these figures in the future are explored. The experience and projections on the impact of discharge heat from nuclear power plants is presented for coastal and inland sites. A review of environmental protection systems suggests that many means are available for alleviating environmental stresses which might occur through discharge heat. (6 references) (auth)

45929 (DOCKET-1155–69) LA CROSSE BOILING WATER REACTOR. Discussion of Effect of Loss-of-Load Accident. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). 18 Aug 1970. 7p. Dep. CFSTI.

For Dairyland Power Cooperative, La Crosse, Wis.

45930 (DOCKET-1155–70) LA CROSSE BOILING WATER REACTOR. Modification of the Main Steam Isolation Valve Control System. (Dairyland Power Cooperative, La Crosse, Wis.). 28 Aug 1970. 4p. Dep. CFSTI.

45931 (DOCKET-50003–48) INDIAN POINT STATION, UNIT NO. 1. Report on Leakage Rate Test of Containment Structure. (Consolidated Edison Co. of New York, Inc., New York). 6 Aug 1970. 25p. Dep. CFSTI.

45932 (DOCKET-50003-49) INDIAN POINT STATION, UNIT NO. 1. Technical Specifications, Change No. 40. (Division of Reactor Licensing (AEC), Washington, D. C.). 10 Sep 1970. 2p. Dep. CFSTI.

Approval is granted to change the technical specifications to permit access to the containment vessel while the primary cooling system is open to the containment vessel. (H.D.R.)

45933 (DOCKET-50010-66) DRESDEN NUCLEAR POWER STATION, UNIT 1. Failure of Motor Operated Valve Prior to Startup. (Commonwealth Edison Co., Chicago, Ill.). 4 Sep 1970. 2p. Dep. CFSTI.

45934 (DOCKET-50016-77) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Technical Specifications Change No. 21. (Division of Reactor Licensing (AEC), Washington, D. C.). 31 Aug 1970. 1p. Dep. CFSTI.

Modification of technical specifications relating to fuel burnup provides for continued reactor operation to the maximum fuel burnup without an examination of subassemblies at 50 per cent burnup. (D.C.C.)

45935 (DOCKET-50029-127) YANKEE NUCLEAR POWER STATION. License No. DPR-3; Technical Specifications Proposed Change No. 92. (Yankee Atomic Electric Co., Westboro, Mass.). 31 Aug 1970. 2p. Dep. CFSTI.

Modification of the size of reactor vessel studs is presented. The proposed modification will reduce stud diameter from 5.25 inches to 4.75 inches. (D.C.C.)

45936 (DOCKET-50146-60) SAXTON REACTOR. Accidental Release of Radioactive Gases. (Saxton Nuclear Experimental Corp., Pa.). 31 Aug 1970. 2p. Dep. CFSTI.

45937 (DOCKET-50219-101) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 60. (Jersey Central Power and Light Co., Morristown, N. J.). 31 Aug 1970. 23p. Dep. CFSTI.

45938 (DOCKET-50219-102) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 62. (Jersey Central Power and Light Co., Morristown, N. J.). 8 Sep 1970. 8p. Dep. CFSTI.

The adequacy of the primary containment and its enclosed safety system components for service under conditions which might result from steam releases inside the drywell is evaluated. (H.D.R.)

45939 (DOCKET-50231-53) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License No. DR-15; Technical Specifications Proposed Change No. 4. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 3 Sep 1970. 16p. Dep. CFSTI.

A revision in the technical specifications for SEFOR operation is proposed and applicable revised pages are included. The revision concerns power limits during the initial approach to full power and parameters observed or measured during steady state operation at 20 MW(t). (H.D.R.)

45940 (DOCKET-50237-67) DRESDEN NUCLEAR POWER STATION, UNIT 2. Capacity Deficiency in Standby Liquid Control Pumping Circuit. (Commonwealth Edison Co., Chicago, Ill.). 25 Aug 1970. 2p. Dep. CFSTI.

45941 (DOCKET-50237-69) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 5 to Appendix A of DPR-19. (Commonwealth Edison Co., Chicago, Ill.). 10 Sep 1970. 3p. Dep. CFSTI.

A change in the technical specifications concerning the main steam line valve high flow trip level setting is proposed. (H.D.R.)

45942 (DOCKET-50244-47) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Faulty Reactor Trip Bistable. (Rochester Gas and Electric Corp., N. Y.). 26 Aug 1970. 2p. Dep. CFSTI.

45943 (DOCKET-50245-39) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 28. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 28 Aug 1970. 11p. Dep. CFSTI.

Modifications to furnace-sensitized stainless steel components of the nuclear steam supply system are presented. The replacement of furnace-sensitized safe ends is described. (H.D.R.)

45944 (DOCKET-50247-41) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 24 (Includes Final Facility Description and Safety Analysis Report, Suppl. 14). (Consolidated Edison Co. of New York, Inc., New York). 28 Aug 1970. 48p. Dep. CFSTI.

45945 (DOCKET-50249-40) DRESDEN NUCLEAR POWER STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 24. (Commonwealth Edison Co., Chicago, Ill.). 4 Sep 1970. 10p. Dep. CFSTI.

Responses to questions concerning various design and safety aspects of the plant are presented. (H.D.R.)

45946 (DOCKET-50250-30) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report, [Amendment 24], Suppl. 24. (Florida Power and Light Co.). 28 Aug 1970. 172p. (DOCKET-50251-28). Dep. CFSTI.

Additional information on the plant design, construction, and operation is presented. The requested information ammends information included in the Final Safety Analysis Report. (H.D.R.)

45947 (DOCKET-50250-31) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Environmental Statement. (Florida Power and Light Co.). 1 Sep 1970. 199p. (DOCKET-50251-29). Dep. CFSTI.

The impact of the Turkey Point plant on the ecology, land use, and aesthetics of the site area is examined. Appendixes to the summary statements on the probable impact include: a proposal for an ecological study of Card Sound; statements on the probable biological, physical, and meteorological effects of the plant; and a chronology of events concerning the plant. (H.D.R.)

45948 (DOCKET-50263-42) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Notice of Issuance of Provisional Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 8 Sep 1970. 7p. Dep. CFSTI.

45949 (DOCKET-50269-22) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 18 (Includes Final Safety Analysis Report, Rev. 10). (Duke Power Co., Charlotte, N. C.). 28 Aug 1970. 78p. (DOCKET-50270-22; DOCKET-50287-19). Dep. CFSTI.

45950 (DOCKET-50269-23) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 19 (Includes Final Safety Analysis Report, Rev. 11). (Duke Power Co., Charlotte, N. C.). 8 Sep 1970. 25p. (DOCKET-50270-23; DOCKET-50287-20). Dep. CFSTI.

45951 (DOCKET-50271-27) VERMONT YANKEE NUCLEAR POWER STATION. Environmental Report. (Vermont Yankee Nuclear Power Corp., Rutland). 1 Sep 1970. 77p. Dep. CFSTI.

The Vermont Yankee Nuclear Power Station occupies a 125 acre site on the Connecticut River at Vernon, Vermont. The reactor is a boiling water type with a net capacity of 540 MW(e). The probable environmental impact of the plant is discussed with regard to thermal, radiological, atmospheric, chemical release, and land use effects. Plant effluent and waste systems are described, and the site geology, hydrology, and meteorology are examined. (H.D.R.)

45952 (DOCKET-50271-28) VERMONT YANKEE NUCLEAR POWER STATION. Final Safety Analysis Report, Amendment 15. (Vermont Yankee Nuclear Power Corp., Rutland). 28 Aug 1970. 86p. Dep. CFSTI.

The reactor core thermal-hydraulic design, to be included as part of the final safety analysis report, is presented. Additional information and revised data in response to questions on the plant design and safety features are included. (H.D.R.)

45953 (DOCKET-50277-11) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Vol. 1. [Preliminary Safety Analysis Report, Amendment 7]. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 350p. (DOCKET-50278-11). Dep. CFSTI.

Information on Peach Bottom Power Reactor Units 2 and 3 is presented under the following broad topics: Introduction and Summary; and Site. (D.C.C.)

45954 (DOCKET-50277-12) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Vol. 2. [Preliminary Safety Analysis Report, Amendment 7]. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 273p. (DOCKET-50278-12). Dep. CFSTI.

Information on Peach Bottom Power Reactor Units 2 and 3 is presented under the following broad topics: Reactor; Reactor Coolant System; and Containment. (D.C.C.)

45955 (DOCKET-50277-13) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Vol. 3. [Preliminary Safety Analysis Report, Amendment 7]. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 315p. (DOCKET-50278-13). Dep. CFSTI.

Information on Peach Bottom Power Reactor Units 2 and 3 is

presented under the following broad topics: Core Standby Cooling Systems; and Control and Instrumentation. (D.C.C.)

45956 (DOCKET-50277-14) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Vol. 4. [Preliminary Safety Analysis Report, Amendment 7]. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 357p. (DOCKET-50278-14). Dep. CFSTI.

Information on Peach Bottom Power Reactor Units 2 and 3 is presented under the following broad topics: Control and Instrumentation; Electrical Power Systems; Radioactive Waste Systems; Auxiliary Systems; and Power Conversion Systems. (D.C.C.)

45957 (DOCKET-50277-15) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Vol. 5. [Preliminary Safety Analysis Report, Amendment 7]. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 297p. (DOCKET-50278-15). Dep. CFSTI.

Information on Peach Bottom Power Reactor Units 2 and 3 is presented under the following broad topics: Conduct of Operations; Structures and Shielding; and Plant Safety Analysis. Information is also presented on pressure integrity of piping and equipment pressure parts. (D.C.C.)

45958 (DOCKET-50277-16) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Vol. 6. [Preliminary Safety Analysis Report, Amendment 7]. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 148p. (DOCKET-50278-16). Dep. CFSTI.

Information on Peach Bottom Power Reactor Units 2 and 3 is presented under the following topics: structural design criteria; quality assurance program; and interaction of Units 1, 2, and 3. (D.C.C.)

45959 (DOCKET-50277-17) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Vol. 7. [Preliminary Safety Analysis Report, Amendment 7]. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 235p. (DOCKET-50278-17). Dep. CFSTI.

Information on Peach Bottom Power Reactor Units 2 and 3 is presented under the following topics: plant nuclear safety operational analysis; conformance to AEC criteria; in-service inspection; identification and resolution of AEC-ACRS and staff concerns; reactor pressure vessel design summary report; reactor core thermal design; containment report; and site meteorology. (D.C.C.)

45960 (DOCKET-50280-27) SURRY POWER STATION, UNITS 1 AND 2. NORTH ANNA POWER STATION, UNITS 1 AND 2. Comments on Deficiencies in Pressure Vessel Fabrication. (Virginia Electric and Power Co., Richmond). 4 Sep 1970. 2p. (DOCKET-50281-27; DOCKET-50338-23; DOCKET-50339-22). Dep. CFSTI.

45961 (DOCKET-50302-14) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 10. (Florida Power Corp., St. Petersburg). 28 Aug 1970. 106p. Dep. CFSTI.

The test program on 1170 ton Prescon tendons for the reactor containment structure is described. Test results are presented. (D.C.C.)

45962 (DOCKET-50309-20) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Amendment 14 (Includes Final Safety Analysis Report, Vol. 1). (Maine Yankee Atomic Power Co., Wiscasset). 27 Aug 1970. 382p. Dep. CFSTI.

The Maine Yankee reactor is a pressurized water type with a core output of 2440 MW(t) and a gross electrical output of 830 MW(e). Commercial operation of the plant is scheduled for mid-1972. Principal design criteria and operating parameters are presented for: (1) the reactor core; (2) cooling system and auxiliary systems; (3) buildings and structures; (4) engineered safeguards; (5) instrumentation and control; and (6) electrical systems. The geology, hydrology, and meteorology of the site are described. (H.D.R.)

45963 (DOCKET-50309-21) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Amendment 14 (Includes Final Safety Analysis Report, Vol. 2). (Maine Yankee Atomic Power Co., Wiscasset). 27 Aug 1970. 381p. Dep. CFSTI.

The Maine Yankee plant design and operating parameters for the auxiliary systems, steam and power conversion system, and radiation protection structures and systems are presented. The conduct of operations procedures, initial tests and operations procedures, and safety analyses of potential operating incidents are described. Included are the AEC power plant design criteria, the quality assurance program, and the technical specifications. (H.D.R.)

45964 (DOCKET-50321-15) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Supplementary Information to the Preliminary Safety Analysis Report. (Georgia Power Co., Atlanta). 28 Aug 1970. 50p. Dep. CFSTI.

Geological data are presented for the site of the intake structure for the Edwin I. Hatch Power Reactor Unit 1. Stress limits for support structures are included. (D.C.C.)

45965 (DOCKET-50329-20) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 16. (Consumers Power Co., Jackson, Mich.). 4 Sep 1970. 6p. (DOCKET-50330-19). Dep. CFSTI.

Additional information concerning the tertiary heat exchange system is presented. (D.C.C.)

45966 (DOCKET-50341-12) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Probable Maximum Water Level. (Detroit Edison Co., Mich.). 28 Aug 1970. 3p. Dep. CFSTI.

45967 (DOCKET-50341-13) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 10. (Detroit Edison Co., Mich.). 31 Aug 1970. 27p. Dep. CFSTI.

45968 (DOCKET-50341-14) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 6. (Detroit Edison Co., Mich.). 15 Jul 1970. 58p. Dep. CFSTI.

Flow diagrams and operational parameters of the reactor core isolation cooling, residual heat removal, low pressure coolant injection, high pressure coolant injection, core spray, and automatic depressurization systems are presented. Actuating devices, set points, and sensors are decribed, and the capacities and redundancies of the systems are indicated. (H.D.R.)

45969 (DOCKET-50341-15) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 7. (Detroit Edison Co., Mich.). 24 Jul 1970. 23p. Dep. CFSTI.

Responses to questions by the Regulatory Staff of the Division of Reactor Licensing are presented. The questions concern various aspects of a loss of coolant accident. (H.D.R.)

45970 (DOCKET-50341-16) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 8. (Detroit Edison Co., Mich.). 3 Aug 1970. 53p. Dep. CFSTI.

Responses to questions concerning various design and safety features of the plant are presented. (H.D.R.)

45971 (DOCKET-50341-17) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 9. (Detroit Edison Co., Mich.). 4 Aug 1970. 31p. Dep. CFSTI.

Responses to questions concerning the design and safety aspects of the plant are presented. The questions are primarily concerned with the provisions for plant emergency power supply. (H.D.R.)

45972 (DOCKET-50348-9) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 4. (Alabama Power Co., Birmingham). 21 Aug 1970. 141p. (DOCKET-50364-3). Dep. CFSTI.

45973 (DOCKET-50354-8) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 2. (Public Service Electric and Gas Co., Newark, N. J.). 11 Sep 1970. 234p. (DOCKET-50355-8). Dep. CFSTI.

Revised and additional data on the design and safety aspects of the plant are presented. The data included are in response to questions on the preliminary safety analysis report. (H.D.R.)

45974 (DOCKET-50361-9) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 1. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 31 Aug 1970. 374p. (DOCKET-50362-8). Dep. CFSTI.

Additional information concerning site geology and seismology is presented. Responses to specific questions concerning the proposed design, construction, and operation of the two units are provided. (H.D.R.)

45975 (DOCKET-50366-2) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 1. (Georgia Power Co., Atlanta). 11 Sep 1970. 328p. Dep. CFSTI.

Information on Edwin I. Hatch Power Reactor Unit 2 is pre-

sented under the following broad topics: Introduction and Summary; Plant Site and Environs; and Reactor. (D.C.C.)

45976 (DOCKET-50366-3) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 2. (Georgia Power Co., Atlanta). 11 Sep 1970. 228p. Dep. CFSTI.

Information on Edwin I. Hatch Power Reactor Unit 2 is presented under the following broad topics: Reactor Coolant System; Containment; and Core Standby Cooling Systems. (D.C.C.)

45977 (DOCKET-50366-4) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 3. (Georgia Power Co., Atlanta). 11 Sep 1970. 340p. Dep. CFSTI.

Information on Edwin I. Hatch Power Reactor Unit 2 is presented under the following broad topic: Control and Instrumentation. (D.C.C.)

45978 (DOCKET-50366-5) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 4. (Georgia Power Co., Atlanta). 11 Sep 1970. 394p. Dep. CFSTI.

Information on Edwin I. Hatch Power Reactor Unit 2 is presented under the following broad topics: Electrical Power Systems; Radioactive Waste Systems; Auxiliary Systems; Power Conversion Systems; Structures and Shielding; Conduct of Operations; and Plant Safety Analysis. (D.C.C.)

45979 (DOCKET-50366-6) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 5. (Georgia Power Co., Atlanta). 11 Sep 1970. 298p. Dep. CFSTI.

Information on Edwin I. Hatch Power Reactor Unit 2 is presented under the following topics: design criteria for piping and equipment; proposed technical specifications; supplementary design criteria; quality assurance program; offgas release calculations; conformance to AEC criteria; plant nuclear safety operational analysis; and inservice inspection. (D.C.C.)

45980 (DOCKET-50367-1) BAILLY GENERATING STATION, NUCLEAR 1. Construction Permit Application. (Northern Indiana Public Service Co., Hammond). 27 Aug 1970. 44p. Dep. CFSTI.

45981 (DOCKET-50367-2) BAILLY GENERATING STATION, NUCLEAR 1. Preliminary Safety Analysis Report, Vol. 1. (Northern Indiana Public Service Co., Hammond). 27 Aug 1970. 581p. Dep. CFSTI.

Information on Bailly Power Reactor Unit 1 is presented under the following broad topics: Introduction and Summary; Reactor; and Site. (D.C.C.)

45982 (DOCKET-50367-3) BAILLY GENERATING STATION, NUCLEAR 1. Preliminary Safety Analysis Report, Vol. 2. (Northern Indiana Public Service Co., Hammond). 27 Aug 1970. 266p. Dep. CFSTI.

Information on Bailly Power Reactor Unit 1 is presented under the following broad topics: Reactor Coolant System; Containment; and Core Standby Cooling Systems. (D.C.C.)

45983 (DOCKET-50367-4) BAILLY GENERATING STATION, NUCLEAR 1. Preliminary Safety Analysis Report, Vol. 3. (Northern Indiana Public Service Co., Hammond). 27 Aug 1970. 381p. Dep. CFSTI.

Information on Bailly Power Reactor Unit 1 is presented under the broad topic of Control and Instrumentation. (D.C.C.)

45984 (DOCKET-50367-5) BAILLY GENERATING STATION, NUCLEAR 1. Preliminary Safety Analysis Report, Vol. 4. (Northern Indiana Public Service Co., Hammond). 27 Aug 1970. 442p. Dep. CFSTI.

Information on Bailly Power Reactor Unit 1 is presented under the following broad topics: Electrical Power Systems; Radioactive Waste Systems; Auxiliary Systems; Steam and Power Conversion System; Station Structures and Shielding; Conduct of Operations; and Station Safety Analysis. (D.C.C.)

45985 (DOCKET-50367-6) BAILLY GENERATING STATION, NUCLEAR 1. Preliminary Safety Analysis Report, Vol. 5. (Northern Indiana Public Service Co., Hammond). 27 Aug 1970. 395p. Dep. CFSTI.

Information on Bailly Power Reactor Unit 1 is presented under the following headings: pressure boundary integrity criteria; outline of proposed technical specifications; equipment design criteria; quality control system; station atmospheric release limit calculations; conformance to AEC design criteria; and station nuclear safety operational analysis. (D.C.C.)

45986 (DOCKET-50367-7) BAILLY GENERATING STATION, NUCLEAR 1. Notice of Receipt of License Application. (Division of Reactor Licensing (AEC), Washington, D. C.). 4 Sep 1970. 3p. Dep. CFSTI.

45987 (DOCKET-50368-1) ARKANSAS NUCLEAR ONE, UNIT 2. Application for Licenses. (Arkansas Power and Light Co., Little Rock). 10 Sep 1970. 77p. Dep. CFSTI.

45988 DYNAMIC EVALUATION OF REACTOR CORE SUPPORT STRUCTURES. Kadakia, Ashvin S. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 13: Suppl., 7-8(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45989 POST-DBA CONTAINMENT HYDROGEN GENERATION: METHODS FOR CALCULATING AND CONTROLLING HYDROGEN-GAS ACCUMULATION. Deackoff, L. P.; Feinstein, J. G.; Vanasse, R. E. (Stone and Webster Engineering Corp., Boston). Trans. Amer. Nucl. Soc.; 13: Suppl., 10-11(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45990 CONTRIBUTION TO SOLUTION OF THE PROBLEMS OF THE BURST CARTRIDGE DETECTION IN THE POWER PLANT A 1. Hladky, Eduard; Melichar, Zdenek (Research Power Inst., Bohunice, Czech.). Jad. Energ.; 16: 73-9(Mar 1970). (In Czech).

The base principles of BCD system in power plant A1 are described. Theoretical relationships for burst cartridge detection sensitivity at nominal reactor parameters are derived. Influences of the general operation parameters upon this sensitivity are analyzed. The BCD system preparedness is valued for three possible types of failure. 10 references. (auth)

45991 MONITORING OF BOILING-TYPE ATOMIC POWER STATIONS ENVIRONMENT. Knyazev, V. A.; Kotikov, P. I.; Laptev, V. G.; Chechetkin, Yu. V. At. Energ. (USSR); 29: 18-21 (Jul 1970). (In Russian).

The organization problems associated with monitoring of the environment in the vicinity of boiling type nuclear power stations under normal operating conditions are considered. It is shown that the radioactive gas discharge into atmosphere up to 1000 curies per day does not make a significant contribution on the total radioactivity of the environment as compared with the global fall-out background. With the fall-out up to 1000 curie it is necessary to take account of the γ-radiation integrated dose in the locality from the radioactive discharge source. 3 references. (auth)

Power Reactor Development

Refer also to abstracts 44187, 44212, 44270, 44382, 44392, 44652, 44657, 44670–44672, 44742, 44760, 44761, 44791, 44816–44818, and 46111.

45992 (AECL-3660) HEAVY WATER MODERATED NUCLEAR POWER REACTORS. Gray, J. L.; Moon, C. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jun 1970. 16p. (CONF-700530-1). Dep. CFSTI (U. S. Sales Only). AECL $0.50.

From International Meeting on Modern Electric Power Stations, Liege, Belgium.

Among heavy water moderated reactors, many variations exist. A number of these variations are discussed and their further commercial development is considered. Special attention is given to the CANDU series of heavy water moderated, natural uranium fueled reactors. (auth)

45993 (ANL-7726) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JULY 1970. (Argonne National Lab., Ill.). 27 Aug 1970. Contract W-31-109-eng-38. 173p. Dep. CFSTI.

Highlights of project activities for July 1970 are summarized. LMFBR physics development, component development, materials technology, and safety studies are reviewed. Operations and analysis of ZPR-3, ZPR-6, ZPR-9, and ZPPR are described. The EBR-2 research and development projects, vendor fuel element reclamation, and operations are summarized. Reactor fuels and materials development, physics studies, engineering development, fuel cycle chemistry, and TREAT operations are reported. (H.D.R.)

45994 (BNL-50205) DEPARTMENT OF APPLIED SCIENCE. Annual Report. (Brookhaven National Lab., Upton, N. Y.). 31 Dec 1969. 186p. Dep. CFSTI.

Separate abstracts were prepared for the 9 sections included. These sections cover the work of seven divisions and two support groups. (J.W.R.)

For abstracts of individual sections see: 44026, 44027, 44056, 44184, 44222, 44654, 45716, 45863, and 46013.

45995 (BNWL-SA-2691) CORE CLAMPING SYSTEM DESIGN FOR FAST REACTORS. Waymire, G. R.; Jackson, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 47p. (CONF-691102-27). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

The advent of irradiation-induced effects in candidate structural materials for fast reactors has resulted in a reassessment of in-reactor structural requirements for Liquid Metal Fast Breeder Reactors, particularly in the area of core clamping. Criteria for core clamping design are proposed. Phenomena resulting in core structural problems are reviewed. The design approaches being pursued for the Fast Test Reactor (FTR) of the Fast Flux Test Facility are described. 5 references. (auth)

45996 (CONF-700307-4) STUDIES OF THE CONSTRUCTION OF THE TANKS FOR THE PHENIX REACTOR AND POWER REACTORS USING INTEGRATED CIRCUITS. Payan, G. (Societe des Forges et Ateliers du Creusot, Paris (France)); Villeneuve, J.; Sauvage, M. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Lagrange, M.; Andre, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Geffroy, B. (Electricite de France, Les Renardieres). [1969]. 25p. (SM-130/33). Dep. CFSTI.

From Symposium on Progress in Sodium-Cooled Fast Reactor Engineering, Monaco.

Significant aspects involved in the design and construction of the reactor vessel for PHENIX are discussed. The mechanical, metallurgical, and technological problems related to the vessel fabrication are described in detail. (8 references) (H.D.R.)

45997 (GA-10202) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM, Quarterly Progress Report for the Period Ending June 30, 1970. (Gulf General Atomic, Inc., San Diego, Calif.). 31 Jul 1970. Contract AT-(04-3)-633. 138p. Dep. CFSTI.

FISSION PRODUCTS—release from coated particle fuels, (E)
FORT ST. VRAIN POWER REACTOR, UNIT 1—steam generator modules for, development of helium seals for
—fuel management program development for
—power distribution in, effects of fuel and burnable poison distribution on, (T)
—physics parameters analysis for
—fuel element design and testing for
—fuel elements for, properties and irradiation stability of graphite in
—core for, properties and irradiation stability of graphite in
—fuels for, preparation and testing of coated particle
—loading machine development for
—steam generators for, development and testing of
GRAPHITE—radiation effects on, fast neutron, (E)
—properties of binder and filler materials for coated particle fuel elements, (E)
NEUTRONS, FAST—effects on properties of graphite, (E)
REACTOR FUELS—properties of coated particle type, (E)
—fabrication methods for coated particle type, (E)
—radiation effects on coated particle type, (E)
THORIUM CARBIDES—ThC_2–UC_2, irradiation testing of coated particles
URANIUM CARBIDES—ThC_2–UC_2, irradiation testing of coated particles (H.D.R.)

45998 PREPARATION AND USE OF RDT STANDARDS FOR THE LMFBR PROGRAM. Nicholson, James O. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 13: Suppl., 12-13(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

45999 SPECIAL DEVELOPMENT PROBLEMS OF HIGH-TEMPERATURE GAS-COOLED REACTORS. Goodjohn, A. J. (Gulf General Atomic, Inc., San Diego); Trauger, D. B. Trans. Amer. Nucl. Soc.; 13: Suppl., 25(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46000 FROM MSRE TO AN MSBR. Briggs, R. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 13: Suppl., 25-6(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46001 SPECIAL DEVELOPMENT PROBLEMS OF THE LMFBR. Koch, L. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 13: Suppl., 26(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46002 SPECIAL DEVELOPMENT PROBLEMS IN GCFR. Guyker, W. C. Jr. (Allegheny Power Service Corp., Greensburg, Pa.); Ver Planck, D. W. Trans. Amer. Nucl. Soc.; 13: Suppl., 26-7(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46003 SOME DEVELOPMENT PROBLEMS IN ADVANCED CANDU SYSTEMS. Pease, Liberty (Atomic Energy of Canada, Ltd., Sheridan Park, Ont.). Trans. Amer. Nucl. Soc.; 13: Suppl., 28(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-7009

46004 CONTRIBUTION OF POWER REACTORS IN AFRICAN COUNTRIES. Gillon, L. P. (Commissariat des Sciences Nucleaires, Kinshasa, Congo). pp 313-18 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The cost components for electric power production and also the characteristics of a variety of exploitable energy sources are analyzed. The energy potential for Africa is briefly surveyed. A second application of power reactors is the production of desalinated water. The production requirements and techniques for this application are discussed. Multipurpose utilization of energy from power reactors is considered, using a large-scale agro-industrial complex as an illustration. (auth)

46005 PEACEFUL USES OF NUCLEAR ENERGY. Gacii, P. (University Coll., Nairobi, Kenya). pp 319-24 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The per capita power consumption of Kenya is compared with that of some more developed countries. With reference to the requirements of Kenya, the questions of costs and economic reactor size are discussed. 5 references. (auth)

46006 DETERMINATION OF TEMPERATURE IN LIQUID METAL-COOLED NUCLEAR REACTOR. Buleev, N. I.; Levchenko, V. E.; Polosukhina, K. N.; Sholokhov, A. A. At. Energ. (USSR); 29: 6-11(Jul 1970). (In Russian).

A method of determining temperatures based on the superposition principle is given. Fundamental unit functions are found which represent temperature variation along a channel axis caused by constant heat generation in a separate fuel element. A formula is given to calculate the temperature distribution using the fundamental unit functions solutions. The formula permits the temperature calculation to be performed in the case when the heat generation rate is different in each fuel element and varies arbitrarily along the element axis. The method is illustrated by an example of the temperature calculation in the case of rod-type fuel elements in a liquid metal fast reactor. Errors caused by a heat transfer coefficient technique are analyzed. 9 references. (auth)

46007 DEVELOPMENT OF COMMERCIAL NUCLEAR POWER IN THE UNITED KINGDOM. Eltham, B. E. Nucleus (Karachi); 6: 185-99(Oct-Dec 1969).

The development of commercial nuclear power in Great Britain since 1955, the various types of reactors, and projections for the future are discussed. The economics of generating cost is also examined in some detail. (auth)

46008 COMPARISON OF THE ECONOMICS OF HTR-GT DEVELOPMENT METHODS. Andrews, David (Rolls-Royce Ltd., Coventry, Eng.). J. Brit. Nucl. Energy Soc.; 9: 153-60 (Jul 1970).

A simple operational study was carried out to compare the economic consequences of four separate methods of developing the power machinery for HTR-GT power stations. Prior development of an HTR-steam power station was assumed in each case. The study shows that gasdynamic testing of the gas turbine units in a

small (~10 MW(e)) fossil-fuel powered test bed, followed by in-situ development in the prototype commercial nuclear reactor, is cheaper, quicker and more effective than alternatives involving: no fossil-fuel powered test bed; a large (~60 MW(e)) fossil-fuel powered test bed; or a single-loop 250–300 MW(e) research reactor. International collaboration appears to be more protracted, and dearer in total cost, but cheaper to each of the partners. The economic return, therefore, appears to be better. No economic justification can be found for the provision of a large research reactor for development of the gas turbine power plant, even on an international basis. (auth) (UK)

46009 REVIEW OF THE NUCLEAR POWER PROGRAM. I. Starkey, J. P.; Bangert, B. A. Nucl. Energy; 11: 118-22(Jul-Aug 1970).

A review of the nuclear power reactor systems is given. The magnox type reactor is discussed. The disadvantages indicated led to the development of Advanced Gas-cooled Reactor stations with their greater thermal efficiency, the more advanced High Temperature Reactor, and the sodium cooled fast Breeder Reactor (FBR). The water cooled reactor systems in the U. S. are discussed and their advantages indicated. Progress in nuclear power station design in Germany and Sweden is considered. The problems of forecasting demand for electricity in the UK up to 1995 are discussed and estimates of the required generating capacity given. The market and the organization needed to exploit it are discussed. It is felt that the combination of one powerful reactor research and design company and one fuel element supply and processing company would be the most efficient method of facing future competition. To allow export sales of FBR systems a balance of FBR and other systems will be necessary in UK stations. (UK)

46010 UTILIZATION OF THERMAL WATER FROM NUCLEAR POWER PLANTS. Kligfield, George (Vitro Corp. of America, Richland, Wash.). pp 173-88 of Developments in Water Quality Research. /Shuval, Hillel I. (ed.). Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers, Inc. (1970).

From Conference on Developments in Water Quality Research, Jerusalem, Israel. See CONF-690644.

Present programs and planned projects for using thermal effluents from power reactors to irrigate farmlands are described. (D.C.C.)

Kinetics and Dynamics

46011 (AI-AEC-12969) LMFBR PHYSICS PROGRAMS. Annual Technical Progress Report, GFY 1970. (Atomics International, Canoga Park, Calif.). 15 Aug 1970. Contract AT-(04-3)-701. 87p. Dep. CFSTI.

CRITICAL ASSEMBLIES—physics measurements on fast reactor cores in ECEL
—physics parameters of fast, VIM-1 Monte Carlo code for analysis of
—criticality calculations for ZPR-3 Assembly 48, comparison of benchmark
—physics parameters of ZPR-3 Assemblies 11 and 48, (E/T)
EUROPIUM OXIDES—reactivity worth in fast reactor spectra, (E)
LIQUID METAL FAST BREEDER REACTOR—cores for, ECEL simulation of conceptual
—physics parameters for, development during July 1969 to June 1970
NEUTRON CROSS SECTIONS—calculations for advanced reactor concepts, SCORE code development for
OXYGEN—reactivity worth in fast reactor spectra, (E)
PLUTONIUM-239—neutron fission rate in fast reactor spectra, effects of core position on, (E)
—neutron cross sections for, comparison of ENDF/B data sets on
PLUTONIUM-240—neutron cross sections for, comparison of ENDF/B data sets on
PLUTONIUM OXIDES PuO_2—reactivity worth in fast reactor spectra, (E/T)
REACTIVITY—Doppler worth effects in fast reactor core materials, (E/T)
REACTOR CONTROL ELEMENTS—reactivity worth of tantalum, in fast spectra, (E)
—gamma radiation heating in fast reactor spectra, (E)
REACTORS, FAST—control elements for, reactivity worth and γ heating of tantalum, (E)
TANTALUM—reactivity worth in fast reactor spectra, (E)
TANTALUM-181—neutron cross sections for, evaluation of data sets on fast
URANIUM-235—neutron fission rate in fast reactor spectra, effects of core position on, (E)
—reactivity worth in fast reactor spectra, (E/T)
—neutron cross sections at 0.015 to 15 MeV, (E/T)
URANIUM-238—reactivity worth in fast reactor spectra, (E/T)
—neutron cross sections for, comparison of ENDF/B data sets on (H.D.R.)

46012 (ANL-7540) COMPARISON OF THE VARIOUS NEUTRONIC REPRESENTATIONS FOR EBR-II ANALYSES. Madell, J. T.; Jarka, R. E. (Argonne National Lab., Ill.). Feb 1970. Contract W-31-109-eng-38. 62p. Dep. CFSTI.

The methods of preparing the input specifications for neutronic analyses of EBR-II are described. The input specifications for one- and two-dimensional calculations include regional designations, volume fractions, atomic densities, and mesh intervals. The production, collapsing, and analyses of various cross-section sets are discussed. EBR-II loadings with steel and depleted-uranium subassemblies in the inner blanket were simulated for one- and two-dimensional calculations. The influence of diffusion and transport approximations and of several cross-section sets on neutronic quantities of these loadings is investigated for one- and two-dimensional calculations. The neutronic quantities obtained from various one-dimensional representations are compared to those obtained from a two-dimensional representation. (20 references.) (auth)

46013 (BNL-50205, pp 1-15) REACTOR PHYSICS DIVISION. Chernick, J. (Brookhaven National Lab., Upton, N. Y.).

A review of the research and development programs of the Reactor Physics Division at Brookhaven National Laboratory is presented for 1969. The review of research programs includes: reactor kinetics; the theory of pulsed fast reactors; resonance absorption of neutrons; space–energy flux synthesis methods; analysis of BNL experiments; analysis of integral experiments; computer code development; reactor safety analysis evaluation; fast reactor cell studies; measurement of delayed neutron parameters for ^{235}U; compilation of fast reactor experiments; fast neutron spectroscopy; Al–D_2O–Pu lattices; and plutonium alpha experiment. 52 references. (D.C.C.)

46014 (BNWL-1492) TIMH: A COMPUTER PROGRAM FOR THE DETERMINATION OF FLUENCE WITH A TIME-VARYING FLUX. Bourquin, R. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

A method is described for calculating flux and fluence from activities induced in neutron-activated foils from irradiations with varying reactor power. The FORTRAN V program that performs calculations according to this method is described, along with input instructions, a complete listing, and an illustrative test case. (auth)

46015 (EURFNR-757) STATIC METHOD FOR SUBCRITICALITY DETERMINATION IN FAST BREEDERS. Glauner, H. W.; Heusener, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-1148. 11p. Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

For the determination of the subcriticality of a fast reactor the method is investigated to measure and evaluate an artificially produced flux-asymmetry in the core. A neutron source is inserted in an asymmetric core position and the resultant neutron flux is measured at two locations. As the flux-ratio of the two measurements is dependent on the subcriticality, it can be used to determine it. The advantage of the method is its simplicity, as there are no additional installations besides the normal flux detectors necessary. (auth)

46016 THREE DIMENTIONAL CALCULATION OF POWER DENSITY AND TEMPERATURES IN A GRAPHITE-GAS REACTOR. Picou, Jean-Loup (Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson, France). Ind. At.; 14: 39-49 (1970). (In French).

The measurements of the flux and the reactivity units of control rods partially engaged in a graphite-gas power reactor are conducted analytically by a method derived from that of Nordheim–Scalettar. The diagram adopted is that of a homogeneous cylindrical reactor seen axially with two multiplying zones and a radial reflector, the analysis being effected by a development in axial harmonics. After the determination of the singularities, characterized by their extrapolation distances, the temperatures are deduced from the local thermal flux standardized at the total power of the reactor. Two codes (Muther-I and II), essentially differing by certain approximations to the heterogeneity borders,

as well as the associated Barcel code for calculating distances of extrapolation, were written in Fortran-IV for the IBM-360/65 Ispra machine. A comparison was made with the values measured on the reactor of the Italian Latina power station and on the French EDF-2 reactor. The theoretical-experimental divergence (a small percentage on the heating of gases shows that these codes give satisfactory results. (auth) (France)

46017 FAST REACTOR GROUP CONSTANTS: CONCEPT OF GROUP CONSTANTS AND EVALUATION OF NUCLEAR DATA. Katsuragi, Satoru (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 12: 453-63(1970). (In Japanese).

Fast group constants sets are indispensable for the study of fast reactor physics. Many sets published abroad have been utilized in Japan. However, these published sets have the shortcoming of not having the effective elastic removal cross sections properly treated. For heavy nuclides, the resonance cross sections have been obtained on the assumption of constant collision density and isolated narrow resonance approximation. Mutual shielding and self-overlapping effects are not taken into account. Nuclear data utilized are thought to be inaccurate. Recent studies have resulted in gradual elimination of these shortcomings, and have aided in producing more reliable fast group constants. The current status of the theory and practical processes used for obtaining advanced fast reactor group constants sets are presented. 80 references. (auth)

46018 CONTINUOUS SLOWING DOWN THEORY APPLIED TO FAST-REACTOR ASSEMBLIES. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 41: 381-93(Sep 1970).

Continuous slowing down theory is applied to the treatment of the elastic moderation of neutrons in a fast-reactor assembly, where strong scattering resonances are prevalent. Three prescriptions for the moderating parameters are studied. Continuous slowing down theory is demonstrated to yield quite accurate results for the neutron spectrum, when the improved prescriptions are used. A method for treating narrow resonance absorption separate from the slowing down calculation, then using the results of the former to attenuate the flux obtained from the latter, is presented and demonstrated to be promising. (auth)

46019 EFFECTS OF ^{239}Pu ALPHA UNCERTAINTIES ON SOME SIGNIFICANT INTEGRAL QUANTITIES OF FAST REACTORS. Gandini, A.; Salvatores, M. (CSN, Casaccia, Italy). Nucl. Sci. Eng.; 41: 452-5(Sep 1970).

In recent times some remarkable uncertainties of the ratio of the neutron capture to fission cross sections, α, of ^{239}Pu in the energy range 0.1 to 30 keV have been pointed out. A broad analysis of the effects of possible errors of the alpha values of ^{239}Pu on integral parameters relevant to fast breeder design is presented to reactor physicists. The integral parameters considered are the breeding ratio, the prompt-neutron lifetime, and the Doppler and the coolant void reactivity effects. (auth)

46020 RESOLVED NARROW RESONANCE REACTION RATES IN FAST-REACTOR MIXTURES. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 41: 455-7(Sep 1970).

An approximate method for computing resolved, narrow resonance reaction rates and neutron slowing down densities in fast reactor mixtures is presented. The basic idea is first to solve the continuous slowing down equations for the "asymptotic" neutron slowing down density, ignoring the narrow resonances. Then the resonance reaction rate is computed for each resonance, starting with the highest energy resonance, using the narrow resonance approximation and the flux constructed from the asymptotic slowing down density, but attenuated due to absorption in higher energy resonances. The resonance absorption is then used to attenuate the asymptotic slowing down density. The accuracy of the continuous slowing down (CSD) theory was demonstrated, and some examples were given to illustrate the feasibility of the proposed method for computing narrow resonance reaction rates. These resonance calculations were based on the Narrow Resonance Approximation without overlap effects and were computed, in some instances, from the asymptotic expressions given for the Doppler J-function. More accurate calculations in which the resonance calculations were based on the NRA with overlap corrections and the Doppler J*-function was evaluated numerically are presented. (auth)

Control Systems

46021 IN-CORE, SELF-POWERED FAST NEUTRON FLUX MONITORS. Upton, J. W. Jr.; Brown, D. P.; Spear, W. G. (Battelle Northwest Labs., Richland, Wash.). Trans. Amer. Nucl. Soc.; 13: Suppl., 14(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46022 IN-CORE DETECTOR CABLES: SIGNALS OR NOISE. Porter, N. S.; Hoitink, N. C.; Jackson, C. N. Jr. (Battelle Northwest Labs., Richland, Wash.). Trans. Amer. Nucl. Soc.; 13: Suppl., 14-15(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46023 HIGH-TEMPERATURE MEASUREMENT INSTRUMENT FOR ADVANCED REACTORS. Billeter, T. R.; Brown, D. P. (Battelle Northwest Labs., Richland, Washington). Trans. Amer. Nucl. Soc.; 13: Suppl., 15-16(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46024 PRELIMINARY CONTROL STUDY OF A 1000-MW(e) MOLTEN SALT BREEDER REACTOR. Sides, W. H. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 13: Suppl., 16-17(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46025 CONTROL SYSTEM FOR THE LMFBR DEMONSTRATION PLANT. Macrae, G. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 13: Suppl., 17(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46026 PROCESS RADIATION MONITORING SYSTEM FOR LARGE PWR'S. Meijer, Christoffel H. (Combustion Engineering Inc., Windsor, Conn.); Hekkala, Barney. Trans. Amer. Nucl. Soc.; 13: Suppl., 21-2(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46027 TRANSIENT DIGITAL CONTROL OF A BOILING-WATER REACTOR POWER PLANT. Ciechanowicz, W.; Lazarevic, B. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng.; 41: 281-93(Aug 1970).

The control-strategy-design problem is investigated. The digital-control system of a model of a nuclear boiling-water reactor power plant of 500-MW electrical output is considered. The proposed approach, i.e., a system partitioning approach, is applied to the case where there are different kinds of interactions inside the system and where the state-vector representation is used to describe the unsteady states of the reactor. The overall control system is investigated for different sampling periods of digital controllers, and for the case where constraints are imposed on the reactivity controller signals. The influence of the real-noise disturbances upon the overall dynamics of a large power reactor is investigated for the case where the control strategy is determined for the ideal white-noise type of disturbance. 10 references. (auth)

46028 COMPUTER CONTROL IN THERMAL AND NUCLEAR POWER PLANTS. Watanabe, Mitsuru; Hatakeyama, Jun-ichi (Fuji Electric Co. Ltd., Tokyo). Fuji Jiho; 43: 546-51(Jun 1970). (In Japanese).

Mention is not made of the semi standardized supervisory computer control system presently used in industrial power plants. The function group system which is now at the practical application level is described. This is a combined system of wired logic and software. The computer control system which is in operation for private thermal power plants is outlined. The planning of a computer control system for a nuclear power plant with the type of the advanced gas-cooled reactor is described. (auth) (Japan)

Shielding

46029 STEEL CONTAINMENT VESSELS: NEW DEVELOPMENTS. Toth, S. J.; Tunnell, G. M. Jr. (Chicago Bridge and Iron, Oak Brook, Ill.). Trans. Amer. Nucl. Soc.; 13: Suppl., 24 (1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

Cooling Systems

Refer also to abstract 44190.

46030 (ANL-7682) THE EBR-II MATERIALS-SURVEILLANCE PROGRAM. II. RESULTS OF SURV-2. Greenberg, Sherman; Strain, Robert V.; Ebersole, Earl (Argonne National

Lab., Ill.). Jun 1970. Contract W-31-109-eng-38. 12p. Dep. CFSTI.

Eight subassemblies containing 15 alloys used in the primary system of EBR-II, and shield graphite canned in Type 304 stainless steel, are being irradiated in the EBR-II core at 700°F for varying periods of time and neutron dosage. Half of the alloy specimens are exposed directly to reactor sodium, and the remainder are sealed in helium. The alloys include AMPCO Grade 18 aluminum bronze; Stellite 6B; Inconel X-750; T-1 tool steel; Berylco-25; Types 304, 347, 416, and 420 stainless steel (the Type 304 in four variations); Type 17-4 PH stainless steel; and tantalum. The second subassembly (SURV-2) has been removed and subjected to a limited examination after 1581 days in the reactor core and an estimated average fluence of 7×10^{19} n/cm^2 at energy levels >0.82 MeV (3×10^{21} n/cm^2 total). Of the materials exposed, only the Berylco-25 and tantalum experienced appreciable weight loss, and thus appear to be unsuitable for use in contact with sodium under the conditions of test. Type 304 stainless steel (from the shield-graphite cans) increased slightly in room-temperature yield strength but remained ductile. There was no evidence of loss of integrity of the canned-graphite neutron-shield structures. Tantalum samples experienced density decreases that were a function of fluence and equivalent to a maximum swelling of 0.4%. (auth)

46031 (CISE-N-137) TREATMENT OF WATER IN A NUCLEAR PLANT TO TEST FUEL ELEMENTS. Di Pietro, R.; Gadda, F.; Ronchetti, C. (Centro Informazioni Studi Esperienze, Milan (Italy)). May 1970. 22p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The CIRENE is a 130-MW(t) direct cycle prototype reactor using natural U as fuel. It is moderated by heavy water and cooled by boiling light water under phase transfer conditions. The characteristics of a coolant in a nuclear installation are outlined. The characteristics of the CART installation, the device for the chemical testing of water used in the fuel element testing, are described with emphasis on its structural materials and operating conditions. The characteristics of the water in circulation, concentration of insoluble corrosion products, and concentration of radiolysis gases were determined. (9 references) (J.S.R.)

46032 (CONF-700307-3) EFFECT OF HYDRAULIC PROBLEMS ON THE DESIGN OF SODIUM-COOLED FAST REACTORS. Duport, J. P.; Constantin, J. P.; Lambert, P. (Societe Grenobloise d'Etude et d'Applications Hydrauliques (France)). [1969]. 35p. (SM-130/32). Dep. CFSTI.

From Symposium on Progress in Sodium-Cooled Fast Reactor Engineering, Monaco.

The phenomenon of cavitation in liquids is described. Hydrodynamic conditions that can cause this phenomenon to appear are analyzed. The possible consequences of cavitation in Na-cooled reactors are discussed. Because of the adverse nature of some cavitation effects, allowance must be made for this phenomenon in the design of various parts of Na circuits. Problems of the cavitation of mixtures, which have a bearing on the regulation at the bottom of assemblies, are described. The principles underlying constructive solutions which can be of use in eliminating the dangers of damage due to cavitation are analyzed. (auth)

46033 (DP-Report-240) ROLE OF GAS BEARING CIRCULATORS IN THE DRAGON REACTOR. Project DRAGON. Shilling, W. F. (Atomic Energy Establishment, Winfrith (England)). Oct 1963. 15p. Dep. CFSTI.

Specifications for a gas bearing circulator were produced by Dragon Project on the basis of relevant experience gained within the organization. Safety and emergency requirements of the unit are outlined. Test results to date indicate that the main difficulties associated with this type of circulator have now been overcome. (auth)

46034 (GEAP-11069) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Report No. 20, January-March 1970. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr 1970. Contract AT(04-3)-189. 64p. Dep. CFSTI.

CORROSION LOOPS—test specimen fabrication for effects of boiling water reactor coolant on piping steels
PIPES—leakage in reactor cooling systems, effects of low-cycle fatigue and service life on, (T)
—failure strength of elbows and tees in, effects of flaws on, (E)
—fatigue cracking of high pressure, effects of flaws on low-cycle, (E)
REACTORS, BOILING—cooling system for, effects of corrosion on low-cycle fatigue life of piping in
REACTORS, WATER COOLED—cooling systems for, probability of piping leakage due to low-cycle fatigue in, (T)
STAINLESS STEEL—fatigue cracking of Type 304, effects of flaws on low-cycle, (E)
—corrosion determination in water by linear polarization measurements, electrochemical monitoring system for
STEEL—corrosion determination in water by linear polarization measurements, electrochemical monitoring system for
—failure strength of A234 carbon, effects of flaws on, (E)
—fatigue cracking of A234 carbon, effects of flaws on low-cycle, (E) (H.D.R.)

46035 (IN-1398) INCIPIENT FAILURE DETECTION BY ACOUSTIC EMISSION: A DEVELOPMENT AND STATUS REPORT. Parry, D. L.; Robinson, D. L. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 111p. Dep. CFSTI.

A practical incipient failure detection system, based on the phenomenon of acoustic emissions from imperfections in structural materials under stress, has been developed and tested on pressure vessels of various sizes and degrees of complexity. The acoustic emission technique has proven capable of rapidly detecting and locating flaws during hydrostatic acceptance and requalification testing of nuclear reactor pressure vessels. The technique, coupled with other standard nondestructive testing techniques, can provide improved capability for the integrity analysis of a wide variety of complex industrial structures. (19 references) (auth)

46036 HYDROGEN RECYCLE. O'Mara, R. L. (Stone and Webster Engineering Corp., Boston). Trans. Amer. Nucl. Soc.; 13: Suppl., 20-1(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46037 PWR: SAFETY AND RELIEF VALVE EXPERIENCE. Montgomery, C. R. (General Public Utilities, Parsippany, N. J.). Trans. Amer. Nucl. Soc.; 13: Suppl., 29-30(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46038 REMOTE EXPLOSIVE TUBE PLUGGING. Johnson, Wayne R. (Babcock and Wilcox Co., Alliance, Ohio); Brown, Robert L. Trans. Amer. Nucl. Soc.; 13: Suppl., 30(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46039 DEVELOPMENT OF CIRCULATORS FOR HIGH-TEMPERATURE GAS-COOLED REACTORS. Yampolsky, J. (Gulf General Atomic, Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc.; 13: Suppl., 37(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46040 OPERATING EXPERIENCE WITH SODIUM PUMPS AT EBR-II. Davis, Joe R.; Perry, William H. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 13: Suppl., 37-9(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46041 IN-LINE VACUUM-DISTILLATION SODIUM SAMPLER. Olson, W. H. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 13: Suppl., 41-2(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46042 PRESENT STATUS OF RESEARCH AND DEVELOPMENT OF PRESSURE VESSEL TECHNOLOGY. Fujimura, Tadato (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 12: 464-8(1970). (In Japanese).

The sizes of reactor pressure vessels are tending to increase rapidly with the trend toward even larger reactor unit outputs. This has posed new problems on the structural integrity of the reactor vessel, and has called for new developments in pressure vessel technology. Requirements for the structural materials, stress analysis and methods of inspection for the purpose of resolving the problems so far experienced with the reactor pressure vessels are presented. (auth)

Fuels

Refer also to abstracts 46127 and 46129.

46043 (GEAP-10028-34) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM, Thirty-Fourth Quarterly Report, February 1970-April 1970. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development

Operation). Jun 1970. Contract AT(04-3)-189. 146p. Dep. CFSTI.

FAST CERAMIC REACTOR—fuel elements for, development during February to April 1970
—core for, design and kinetics analyses of
—safety of, transient overpower and coolant loss effects on
LIQUID METAL FAST BREEDER REACTOR—fuel elements for, development of stainless steel clad plutonium oxide (PuO_2)–uranium oxide (UO_2) pin type
NEUTRONS, FAST—effects on plutonium oxide (PuO_2)–uranium oxide (UO_2) and stainless steels
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects testing of fuels of, fast neutron
—PuO_2–UO_2, properties of fuels of, mechanical and physical
REACTOR FUEL ELEMENTS—cladding for plutonium oxide (PuO_2)–uranium oxide (UO_2) pin type, development and testing of stainless steel
—performance of defected plutonium oxide (PuO_2)–uranium oxide (UO_2), in flowing sodium
—performance of plutonium oxide (PuO_2)–uranium oxide (UO_2) pin type
STAINLESS STEEL—radiation effects on fast reactor fuel element cladding, fast neutron (D.C.C.)

46044 (ORNL-TM-3027) SPRAY, MIST, BUBBLES, AND FOAM IN THE MOLTEN SALT REACTOR EXPERIMENT. Engel, J. R.; Haubenreich, P. N.; Houtzeel, A. (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 102p. Dep. CFSTI.

The fuel pump bowl in the MSRE incorporated a ring from which 50 gpm of salt was sprayed through the cover gas and into the salt pool. The device effectively removed Xe from the fuel as intended, but also produced several incidental effects. Although none seriously interfered with operation, considerable effort was spent on elucidation of these effects. The spray produced a mist of salt droplets, some of which drifted into the offgas line at a rate of a few grams per month. The resultant salt deposits required cleanout at intervals of six months to a year. The stripper jets also drove bubbles several inches into the salt pool, reducing the average density and raising the actual level above that indicated by the bubbler level elements. Some salt transferred into the overflow line, apparently as froth although there was no evidence of persistent foam. Most of the bubbles driven into the salt returned to the surface, but a small fraction was drawn into the circulating loop. The situation was such that small changes in pump speed or physical properties of the salt changed the depth of the bubble zone enough to change the volume fraction of gas in the loop over the range from 0.02% to 0.7%. (auth)

46045 (WARD-3791-33) EXPERIMENT DESCRIPTION AND SAFETY ANALYSIS FOR 13 (U,Pu)C-FUELED EXPERIMENTAL MkA CAPSULES. Harbourne, B. L.; Lipps, A. J. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1969. 64p. Dep. CFSTI.

A test program for Na-bonded mixed carbide fuel pins under fast flux conditions (in EBR-II) is described. The 13 capsules are described and the safety analysis for their operation is presented. These capsules contain fuel pins that will operate at 20 and 30 kW/ft to burnups in the ranges 20,000 to 30,000 MWD/T and 40,000 to 60,000 MWD/T. A reactor operating power of 50 MW(t) was assumed for the design. It is concluded from the safety analysis that this experiment presents no hazard to the operation of EBR-II. (15 references) (auth)

46046 (WARD-4135-6) FUEL ROD DESIGN LIMIT AND TRANSIENT SURVIVAL CRITERIA. Carelli, M. D. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jul 1970. Contract AT(30-1)-4135. 154p. Dep. CFSTI.

The design limit and transient survival criteria for typical fuel elements of large Liquid Metal Fast Breeder Reactors (LMFBR) currently developed were quantitatively examined. An extensive review of the limiting conditions (essentially maximum allowable cladding and fuel temperatures, and tolerable amount of molten fuel) was carried out; the review indicates that such conditions are rather conservative with respect to the expected failure limits. The operational and off-normal transients which have a credible probability of occurring were thoroughly examined, their expected frequency during the fuel element lifetime evaluated, and their effect on the fuel and cladding temperature assessed. Five significant transients were quantitatively studied: abnormal scram, total loss of electrical power, primary pump seizure, control rod withdrawal error at full power, and small gas bubbles passing through the core. The resultant thermal and mechanical behavior of the fuel and cladding was analyzed for each transient. The maximum allowable amount of molten fuel during transients of the reactivity insertion type was determined, as well as the limiting cladding temperature during flow-reduction transients. The fatigue effect of repeated transients of the same kind was evaluated. An experimental test program for the purpose of studying the effect of the cumulative damage due to superimposing various transients of different types was suggested and outlined. Recommendations for future work were proposed. 81 references. (auth)

46047 LMFBR COMPONENT MATERIALS APPLICATIONS AND PROBLEMS. Bauer, Arthur A.; Conner, Jack G. (Battelle Columbus Labs., Columbus, Ohio). Trans. Amer. Nucl. Soc.; 13: Suppl., 40-1(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46048 DESIGN AND DEVELOPMENT OF FAST REACTOR FUEL ASSEMBLIES. Balent, R. (Atomics International, Canoga Park, Calif.); Hirst, W. H. Trans. Amer. Nucl. Soc.; 13: Suppl., 42-4(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46049 AXIAL RATCHETTING OF FUEL UNDER PRESSURE CYCLING CONDITIONS. Duncombe, Eliot; Goldberg, Ivan (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Appl. Technol.; 9: 47-59(Jul 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

The various additions to the CYGRO fuel rod analysis technique in order to calculate ratchetting effects are described. These effects include fuel cracking, clad collapse, friction between fuel and clad, clad anisotropy and effects of neutron flux on clad creep. By reasonable choice of parameters good agreement can be obtained with tests on axial elongations of non-free-standing fuel rods. There is a pronounced sensitivity of these predictions to the value of creep enhancement as a result of neutron flux. Predictions of diameter changes are believed to be inherently less accurate because of the masking effects of ridging, wrinkling and clad collapse. (auth)

46050 COMPUTER PROGRAM TO PREDICT THE PERFORMANCE OF UO_2 FUEL ELEMENTS IRRADIATED AT HIGH POWER OUTPUTS TO A BURNUP OF 10,000 MWd/MTU. Notley, M. J. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Appl. Technol.; 9: 195-204(Aug 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

A computer program, ELESIM, is described which calculates the behavior of UO_2 pellet fueled elements during irradiation. Whenever possible prediction and experimental observation are compared to verify that the models developed for calculation are reasonable. The interaction of variables when operating with high internal fission gas pressures (and hence reduced fuel-sheath heat transfer coefficient) is emphasized. (4 references) (auth)

46051 INTERNAL GAS PRESSURE BEHAVIOR IN MIXED-OXIDE FUEL RODS DURING IRRADIATION. Burley, T. B.; Freshley, M. D. (Battelle Northwest Lab., Richland, Wash.). Nucl. Appl. Technol.; 9: 233-41(Aug 1970).

Plenum gas temperature and internal gas pressure buildup were measured during irradiation in four vibrationally compacted UO_2–2 wt% PuO_2 fuel rods. Two each of the four instrumented fuel rods operated to peak burnups of 9900 and 6000 MWd/MTM, respectively. The rates of pressure buildup in the high and low burnup fuel rods, which correspond to about 25% and 13% fission gas release, respectively, were consistent with fuel temperature dependent fission gas release fractions predicted from postirradiation gas collection data obtained from similar fuel rods. Measured plenum gas temperatures during irradiation varied directly with coolant outlet temperature. (auth)

46052 APPRAISAL STUDY OF CO_2 GAS-COOLED HEAVY WATER MODERATED REACTOR. POINT BURN UP CALCULATION OF CLUSTER FUEL. Tanaka, Ryokichi; Mori, Koichi; Watanabe, Takashi; Sakano, Kosuke (Kawasaki Heavy Industries, Ltd., Kobe, Japan). FAPIG (Tokyo); No. 51, 172-9(Nov 1968). (In Japanese).

The outline of the code PBS-I developed for the evaluation of point burnup in the analysis of the nuclear properties of a CO_2 gas cooled heavy water moderated power reactor, and the result of calculation for the burnup characteristics of cluster fuel are reported. PBS-I code enables economical calculation without sacrificing accuracy. (Japan)

46053 BURNUP AND FISSION PRODUCT BEHAVIOR IN HIGH-BURNUP TEST FUEL ELEMENTS. Trinkl, A.; Ammen-

torp-Schmidt, F. (Kernenergieversuchsanlage, Grossweizheim, Ger.). Atomwirt., Atomtech.; 15: 402-4(Aug 1970). (In German).

In the framework of developing fuel elements for steam-cooled fast reactors, three test elements were studied in reactor test loops. Analysis of burnup was performed by mass spectrometry of U isotopes and by γ-spectrometry of ^{144}Ce directly from the fuel element dissolved in HNO_3. Fission product concentration also was determined by γ-spectrometry. Fission gases were measured by γ-spectrometry (^{85}Kr), and by mass spectrometry (Xe isotopes). Isotope groups of Pu and transplutonium elements were separated and then measured either by α-spectrometry or by mass spectrometry; their radial distribution was determined by autoradiography with cellulose nitrate foils subjected to subsequent etching in NaOH solution. 8 references. (H.B.G.)

46054 DEVELOPMENT OF COATED PARTICLE FUELS FOR HIGH TEMPERATURE REACTORS. Shepherd, L. R. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc.; 9: 173-88(Jul 1970).

The problem of fission product retention is discussed. The development of coated fuel particles is followed from early work on pyrocarbon coated UC or ThC–UC fuel to recent work on the DRAGON project, which is based mainly on oxide kernels with SiC sandwiched between pyrocarbon coatings and with an overcoating produced from carbonised rusinated graphite power. Factors determining particle specification, such as feed fuel rating, thermal power density, feed enrichment of fuel, and duration of fuel cycle, are discussed. The theoretical behaviour of coated fuel particles in operation is considered and experimental results are presented for both ThC and low-enrichment UC fuel cycles. (UK)

46055 HYBRID COMPUTER SOLUTION OF THERMAL ENERGY EQUATIONS IN POROUS FUELS. Marr, W. W. (Argonne National Lab., Ill.); El-Wakil, M. M. Nucl. Sci. Eng.; 41: 271-80(Aug 1970).

A serial (discrete-time continuous-space) method is employed to solve the unsteady-state energy equations in porous systems on a hybrid computer. The nonlinear, coupled partial-differential equations are solved by replacing the time derivatives with backward finite-differences approximations. To increase the order of accuracy in the time increment of the solution, the Crank–Nicholson scheme is used. The resulting difference-differential equations are solved in the direction opposite to that of the fluid flow to eliminate computational instability. The average temperatures over the consecutive time steps are solved on the analog portion of the hybrid computer. Solutions of the present time step are obtained by combining the analog solutions with those of the previous time step stored in the digital computer. The commonly encountered, mixed boundary conditions are satisfied by using a steepest descent iteration scheme based on least-squares-error minimization. A so-called binary-search technique provides reasonable initial trial values from which the iteration process converges. The trial values are improved by making use of the parameter influence coefficients that are obtained by taking finite differences through a number of test runs at the beginning of the solution and are taken to be constant during the entire solution time. In most cases, the iteration process converges in two to three iterations per boundary value searched. Comparisons of the hybrid computer solutions agree with those obtained by other numerical methods on a digital computer within 1%. (auth)

46056 PREDICTION OF BURNOUT HEAT FLUX FOR ROD CLUSTERS. Nagai, Masayuki (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 19: 140-5(Apr 1970).

The cluster-type fuel element used in heavy-water-moderated power reactors, because of its extremely narrow rod-to-rod gap, produces a lower burnout flux than does the conventional light-water reactor. The effects of various parameters on the burnout heat flux are analyzed. Data fitting was performed by the multiple regression method, using as the major parameters the minimum rod-to-rod gap and dimensions of subchannels under thermally severe conditions, in addition to flow rate and boiling length (or steam quality) which have been employed in conventional formulas. A computation formula that reproduces experimental data with an accuracy of ±10% could be worked out by treating the burnout heat flux of fuel rods on the outer part of the cluster separately from that of fuel rods on the inner part. (auth) (Japan)

Auxiliary and Emergency Systems

46057 (BAW-10019) SYSTEMATIC FAILURE STUDY OF REACTOR PROTECTION SYSTEMS. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Sep 1970. 119p. Dep. CFSTI.

The details of an analysis performed to verify the ability of the reactor protection system to deal with systematic or common mode failure are presented. The analysis was carried out by assuming that the first trip setpoint reached during the course of the accident fails to trip the reactor. The situations analyzed include the following: (1) Rod withdrawal from power; (2) Startup accident; (3) Rod ejection accident; (4) Loss-of-coolant flow; (5) Dropped control rod; (6) Emergency core cooling system actuation; (7) Secondary side malfunction (turbine trip; loss of feedwater flow). In general the results of the analyses are quite favorable. The protection system prevents gross system damage in any given accident situation, even when it is assumed that the primary trip mode has failed. (auth)

46058 (PG-Report-971) MONITORING OF MOVEMENTS OF IRRADIATED FUEL IN AN ON-LOAD REFUELLING REACTOR. Buckley, G.; Willis, A. (United Kingdom Atomic Energy Authority, Sellafield (England). Production Group); Goodwin, C.; Janisch, D. B. (United Kingdom Atomic Energy Authority, Risley (England). Production Group). Apr 1970. 17p. Dep. CFSTI (U. S. Sales Only).

The instrument consists of two sensing heads which can be installed either in the refueling machine itself or somewhere else on the route through which the irradiated fuel passes on its way to the storage facility. By means of a suitable circuit it is possible to operate either digital counters or alternatively a recording device whereby the strength of the gamma field can be plotted against time. The instrument has been used successfully on the Windscale Advanced Gas-Cooled Reactor and is currently being installed for further trials on one of the Magnox reactors at Bradwell. (auth)

46059 DESIGN BASIS FOR THE PROTECTION SYSTEM AND THE ACTUATOR SYSTEMS OF NUCLEAR-FUELED GENERATING STATIONS. Ferguson, R. L. (Atomic Energy Commission, Washington, D. C.); Holland, L. K.; Ebersole, J. C. Trans. Amer. Nucl. Soc.; 13: Suppl., 17-18(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46060 PRESSURE RELIEF DEVICES FOR WATER-COOLED NUCLEAR REACTOR SYSTEMS. Bush, W. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 13: Suppl., 20(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46061 IMPROVEMENTS IN GAS PURIFICATION PLANT. (to Gutehoffnungshutte Sterkrade Aktiengesellschaft). British Patent 1,202,252. 12 Aug 1970. Priority date 22 Dec 1966, Germany.

A coolant purification plant for a gas-cooled reactor is made up of an iodine absorber, a recuperative heat-exchanger, and another absorber for impurities having low boiling points all contained in a gas-tight container with inlet and outlets for the gas. The inlet gas flows through the components in the order mentioned above. A second gas-tight container can be connected to the gas inlet of the first container so that the gas flows through a dust filter, a heater, and an oxidizer disposed in the container prior to entry into the second chamber and into the iodine absorber. (B.L.M.)

Operation and Economics

Refer also to abstract 46103.

46062 (BNWL-965) FUEL CYCLE PARAMETERS OF SODIUM COOLED FAST BREEDERS. Nunn, S. E.; Deonigi, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1968. Contract AT(45-1)-1830. 154p. Dep. CFSTI.

A study is made of the parameters influencing Na-cooled fast breeder reactor performance. Doubling time is defined and factors influencing doubling time are discussed. Sensitivity of fuel cycle cost to Pu price, turnaround time, separation cost, fabrication cost, load factor, and cost of money are determined. The LMFBR's influence on power cost to the U. S. economy is determined as a function of date of introduction, recycle turnaround time, and the doubling time. Fuel management as affected by core and blanket discharge frequency, fuel fabrication and separation cost, and blanket thickness are also discussed. 8 references. (auth)

46063 (DP-Report-335) PLUTONIUM FUEL CYCLE STUDIES FOR A LARGE HIGH-TEMPERATURE GRAPHITE MODERATED REACTOR. Project DRAGON. Bruneder, H.; Haubert, P.

(Atomic Energy Establishment, Winfrith (England)). Apr 1965. 49p. Dep. CFSTI.

Physics and optimisation studies of large (1250 MW; 10 MW/m³) plutonium-fuelled reactors are carried out. Either uranium-238 or thorium is considered as fertile material. Complete core replacement is assumed. (auth)

46064 (DP-Report-336) ^{235}U-THORIUM FUEL CYCLES IN GRAPHITE MODERATED SYSTEMS. Project DRAGON. Blomstrand, J. H.; Schlosser, J.; Bruneder, H.; Nyffenegger, U.; Graziani, G. (Atomic Energy Establishment, Winfrith (England)). Apr 1965. 45p. Dep. CFSTI.

Results from calculations on both once-through and reprocessing fuel cycles are presented. Different fuel management schemes have been considered. Fuel costs are evaluated for a wide range of values for the cost parameters involved. (auth)

46065 CALCULATIONAL MODELS FOR FAST REACTOR FUEL-CYCLE ANALYSIS. Hirons, Thomas J.; O'Dell, R. Douglas (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl. Technol.; 9: 93-106(Jul 1970).

The economic analysis of a large fast breeder is dependent on fuel-cycle parameters, such as fuel discharge rate and breeding ratio. The variation of fuel-cycle parameters with several burnup-model characteristics was studied. These characteristics are the amount of region detail used in describing the reactor, the initial fissile content of the reactor, the maintenance of criticality during the burnup step, the distribution of the control poison during the burnup step, and the flux or power shift over the reactor lifetime. Each of these model characteristics was studied in detail for its effect on the burnup history of the reactor. The mass balances obtained from several of the burnup studies were input to a reactor economics code to determine the economic effects of changes in the model characteristics. The greatest effect on the fuel-cycle analysis was produced by the treatment of the relative flux shift between burnup intervals. (auth)

46066 UTILITY INCENTIVES FOR IMPLEMENTING CROSSED-PROGENY FUELING. Lang, L. W. (Douglas United Nuclear, Inc., Richland, Wash.). Nucl. Appl. Technol.; 9: 242-9 (Aug 1970).

The power costs of three hypothetical reactor sites are analyzed to compare the site-costs of conventionally fueled fast and thermal reactors with Th-blanketed breeders and ^{233}U fueled light water reactors. Since the most critical parameter is time, three case variations are considered. The site startup is considered coincident with the commercial introduction of the fast reactor; and alternatively, where site startup occurs five and ten years after the commercial introduction of the breeder. The cost comparisons also consider the effect of U_3O_8 price increases. The value of ^{233}U produced by thorium blanketed breeders exceeds that of the Pu produced by ^{238}U blanketed breeders. Since the power costs of the LWR's are lower than the breeders until the price of U_3O_8 increases, early development of the breeders may be contingent upon implementation of the crossed-progeny fueling. (auth)

Safety and Siting

Refer also to abstract 46090.

46067 (AI-AEC-12970) LMFBR SAFETY PROGRAMS. Annual Technical Progress Report, GFY 1970. (Atomics International, Canoga Park, Calif.). 15 Aug 1970. Contract AT-(04-3)-701. 79p. Dep. CFSTI.

AEROSOLS — distribution in LMFBR systems, effects of liquid sodium combustion on, (E/T)
LIQUID METAL FAST BREEDER REACTOR — safety programs for, review of GFY 1970
— coolant combustion in, effluent transport studies for liquid sodium, (E/T)
— coolant boiling in, heat transfer characteristics for liquid sodium, (E/T)
REACTOR SAFETY — development programs for LMFBR, review of GFY 1970
— coolant boiling and combustion in LMFBR, characteristics of liquid sodium,
SODIUM — boiling of liquid, effects on LMFBR systems of
— combustion of liquid, effects on LMFBR systems of, (E/T)
(D.C.C.)

46068 (BNWL-1125) AEROSOL TRANSPORT IN A CONDENSING-STEAM BOUNDARY LAYER. Hales, J. M.; Horst, T. W.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 1 Jun 1970. Contract AT(45-1)-1830. 63p. Dep. CFSTI.

Results of a theoretical investigation of aerosol transport in a laminar, naturally convected, condensing-steam boundary layer are reported. Boundary-layer equations were extended to account for aerosol transport and solved for various cases of interest using a hybrid-computer technique. Effects of diffusiophoresis, thermophoresis, and Brownian motion are included in the aerosol-transport analysis. Solutions are presented as profiles of temperature, velocity, steam concentration, and aerosol concentration. These are employed to obtain corresponding heat-transfer, aerosol-deposition, and condensation rates. For very small particle sizes, aerosol-deposition rates were found to decrease with increasing particle size. For larger sizes, however, deposition rates were found to be independent of particle size, and subject only to conditions within the air-steam boundary layer. Computed deposition rates were compared with rates estimated by assuming particles to be deposited with the mass-average velocity of the air-steam mixture. Deposition rates estimated in this manner ranged from about 60% to 20% below those computed via the boundary layer model, depending on physical conditions of the system. Steam condensation rates computed from the boundary-layer equations were compared with those estimated from experimental heat-transfer data on the basis of a heat-transfer–mas-transfer analogy. This comparison showed the analogy to be quite accurate over the range of conditions studied. The computed results are discussed primarily in the context of nuclear reactor containment-vessel analysis, where the deposition of aerosols in condensing steam environments is of particular interest. These results, pertaining to laminar boundary layers only, are insufficient for a total description of containment-vessel behavior, where turbulence as well as a variety of engineered safeguard measures may be present. (auth)

46069 (BNWL-CC-2369) FAST REACTOR FUEL INTERACTION WITH A CONCRETE FLOOR AFTER A HYPOTHETICAL CORE MELTDOWN. Jansen, G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 8 Jan 1970. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

In a core meltdown the heat generated by fission product decay, instead of being removed by coolant, creates temperatures as high as 3550°C in the fuel. A molten mass of fuel and structural material may then deposit on the floor of the core cavity. If the rate of heat generation by radioactive decay is greater than the loss by conduction through the floor and by upward radiation and convection to the reactor containment cavity, the fuel core may melt a hole through the floor and penetrate the reactor containment shell, releasing radioactive fission products to the external evironment. The results of preliminary calculations of the penetration by core material from the Fast Flux Test Facility (FFTF) into a concrete floor made with basalt aggregates are presented. The fission product heat generation rate and the basic assumptions used in the chemical and heat transfer calculations are described. The mechanical integrity of the concrete and the behavior of the moisture in the concrete are then discussed. The melting ranges of molten concrete components and the available data on the solubility of fuel compounds in the molten concrete are evaluated prior to the consideration of fuel-concrete interactions during pool formation. The size of the molten pool is then estimated as a function of heat transfer rates, pool shape, and whether upward heat transfer is impeded by crust formation. (28 references.) (H.D.R.)

46070 (NEDO-10174) CONSEQUENCES OF A POSTULATED FLOW BLOCKAGE INCIDENT IN A BOILING WATER REACTOR. Scatena, G. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). May 1970. 100p. (70-NED-9).

The effects of a fuel bundle flow blockage in a boiling water reactor have been investigated. The consequences in terms of fuel damage, fission product release, local high-pressure production, and possible propagation to adjacent assemblies have been evaluated. The conclusions reached are that a flow blockage incident will not result in local high-pressure production or propagate to adjacent assemblies even at full reactor power conditions. Fuel cladding failure will only occur for blockages greater than 90% even for the most severe combination of events, namely a complete flow blockage at full power. The reactor protection system offers adequate protection in preventing cladding or fuel melting. (63 references) (auth)

46071 (ORNL-TM-3061) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR MAY-JUNE 1970. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 162p. Dep. CFSTI.

AEROSOLS — removal of solid, efficiency of reactor containment system filters for, (E/T)

CHARCOAL—combustion of, effects of fission product decay heat on
FILTERS—efficiency for removal of reactor accident generated aerosols, (E/T)
FISSION PRODUCTS—removal of aerosol, efficiency of reactor containment system filters for, (E/T)
INFORMATION CENTERS—operation of Nuclear Safety, during May to June 1970
IODINE—removal from reactor containment systems, efficiency of borated water sprays for
LIQUID METAL FAST BREEDER REACTOR—fuel element assembly failures in, facility for mockup testing of
NOZZLES—stresses in reactor pressure vessel, effects of attachment configuration on, (E/T)
NUCLEAR SAFETY PILOT PLANT—spray systems for, iodine removal by borated water, (E/T)
PIPE FITTINGS—stress analysis for tees, branch connections, and elbows in reactor systems, (E/T)
PRESSURE VESSELS—structural behavior of reactor, heavy section steel technology program on
REACTOR CONTAINMENT SYSTEMS—spray systems for, efficiency of fission product removal by, (E/T)
—pressure suppression system for, fission product removal by pool, (E/T)
REACTOR FUEL ELEMENTS—failure modes of Zircaloy clad,
—cladding for rod type, high temperature and metallurgical properties of Zircaloy
—cladding for rod type, effects of coolant loss accidents on Zircaloy, (E/T)
REACTOR SAFETY—research and development program during May to June 1970
REACTOR SAFETY EXPERIMENTS—fuel element failure in TREAT, transient tests on Zircaloy clad
REACTORS, GAS-COOLED—safety studies for high temperature, May to June 1970
REACTORS, WATER-COOLED—fuel element cladding for, effects of coolant loss transients on Zircaloy, (E/T)
SPRAYS—efficiency of borated water, for fission product iodine removal
STANDARDS—development of reactor engineering, by U. S. AEC
STEEL—properties of A533, for use in reactor pressure vessels
ZIRCALOY—mechanical properties of, high temperature, (E) (D.C.C.)

46072 (WAPD-T-2222) ASSESSMENT OF SAFETY INJECTION STRATEGIES DURING LOSS OF COOLANT ACCIDENTS. Bauer, D. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). [nd]. Contract AT(11-1)-Gen-14. 131p. (CONF-691102-25). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

The results of 20 PWR low pressure blowdown tests are summarized. The specific purpose of the PWR testing was to assess the effect of different spray patterns and injection locations on channel flow and test plate cooling. The apparatus used simulated the Shippingport pass-and-a-half configuration (two pass blanket; one pass seed). "Seed" test section heat fluxes were varied up to 8000 Btu/hr-ft^2; safety injection rates were varied between 1.25 and 2.5 gpm. Cooling was judged successful if plate temperatures could be maintained below an automatic tripout point of 1200°F. The major observations emerging from the tests were: (1) Injection above the test sections in the upper plenum encourages upward flow steam and percolation cooling of the plates. (2) The effectiveness of above core injection depends upon its dispersion at different times during the transient. (3) The effectiveness of below core injection depends upon its volume delivery rate and arrival time at the bottom of the channels, not its dispersion. (4) For seed test section heat fluxes of ~8000 Btu/hr-ft^2 bottom or top injection alone was insufficient to cool the test sections for any injection rates up to 2 gpm. (Water stacked up above the plates.) (5) Successfully cooled tests were characterized by upward flow of a steam-water mixture and the absence of channel superheat. (auth)

46073 LOSS-OF-COOLING ACCIDENTS IN A GAS-COOLED FAST REACTOR. O'Brien, H. G.; Burke, O. W.; Walker, C. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 13: Suppl., 27-8(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46074 DESIGNS FOR CONTROL OF BWR RADIOACTIVE EFFLUENTS. Falk, C. F.; Michels, L. R. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc.; 13: Suppl., 30-2(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46075 EXPLOSIVE DISASSEMBLY OF FAST SPECTRUM NUCLEAR REACTORS. Lee, John Chaeseung. Berkeley, Calif.; Univ. of California (1969). 213p.

Thesis.

Theoretical analysis of the explosive disassembly of fast spectrum nuclear reactors, following accidental loss of coolant and melting and gravity compaction of the fuel material, is presented. The increase in the energy released in a disassembly transient due to zoned fuel loading is as much as 35 percent for a large fast breeder reactor. The effect on the energy release of the assumption of fixed fuel density in the equation of state is insignificant. Energy release in cylindrical geometry is calculated properly taking the effects due to zonal interfaces into consideration. The effect of the assumption of fixed fuel density in the equation of state, thereby neglecting pressure wave propagation, is studied in spherical geometry. An extension of the Bethe–Tait analytical model to zoned spherical and homogeneous cylindrical cores is made, from which a scheme for obtaining a spherical core equivalent to a cylindrical core is suggested. An analytical estimate of the envelope for the oscillations in energy release in transients with large Doppler feedback is obtained. (Diss. Abstr.)

Power Conversion Systems

46076 (DP-Report-339) THERMODYNAMICS OF THE DIRECT GAS TURBINE POWER CYCLE FOR H.T.G.C. REACTORS. Project DRAGON. Von Bonsdorff, M. G. (Atomic Energy Establishment, Winfrith (England)). Apr 1965. 39p. (CONF-650582-7). Dep. CFSTI.

From Nuclear Gas Turbine Power Plant Colloquium, Paris, France.

A parametric study of the thermodynamics of the closed gas turbine cycle as the power conversion system of a high temperature gas cooled reactor power plant is presented. The effects of changing thermodynamic variables and component design parameters on net plant efficiency, turbine pressure ratio and recuperative heat exchanger size have been computed. A random sampling method has been used to estimate the probability of a predicted value of net plant efficiency. Helium has been assumed as working gas but argon and air are considered for comparison. (auth)

46077 NUCLEAR ONCE-THROUGH STEAM GENERATOR. McDonald, B. Norval (Babcock and Wilcox Co., Barberton, Ohio); Johnson, Lowell E. Trans. Amer. Nucl. Soc.; 13: Suppl., 19-20 (1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

Research and Test Reactors

Refer also to abstracts 44754, 44755, 44782, 44813, 45859, 45923, 45993, 45995, 46069, and 46122.

46078 (AAEC/TM-533) INVESTIGATIONS OF FLUX DISTRIBUTIONS AND REACTIVITY EFFECTS IN HIFAR USING TWO-DIMENSIONAL MODELS. Culley, D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1970. 48p. Dep. CFSTI (U. S. Sales Only).

An attempt has been made to represent the reactor HIFAR using the diffusion code CRAM. The variation of neutron flux across core and reflector, and the effect of course control arm angle on safety rod worth and core excess reactivity, have been investigated using a model in R–Z geometry. Comparisons with operational data have been made. Flux distributions within the core and the effects of rigs and partially burnt fuel elements have been studied in greater detail using an X–Y geometry representation of the reactor. (auth) (Australia)

46079 (AECL-3523) OPERATION OF THE WR-1 ORGANIC COOLED RESEARCH REACTOR. Tegart, D. R. (Atomic Energy of Canada, Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Aug 1970. 12p. (CONF-691009-10). Dep. CFSTI (U. S. Sales Only). AECL $0.50.

From Conference on Reactor Operating Experience, San Juan, Puerto Rico.

The organic cooled, heavy-water moderated, Canadian research reactor WR-1 has operated during the past four years at coolant outlet temperatures up to 375°C and with an average availability of over 85%. Its operation is claimed to be more trouble free than that of a pressurized water system, due chiefly to the high temper-

ature obtainable with low operating pressure in the primary system and the very low radiation fields encountered near the primary piping. Coolant chemical control, equipment performance and fuel management are all discussed, as are some of the problems peculiar to the use of organics, such as fire hazards. The future prospects of the organic-cooled concept indicate that overall efficiencies of between 37 and 39% would be expected. (auth)

46080 (BNWL-1382) EXPERIMENT DESCRIPTION FOR PNL MIXED OXIDES (UO_2-PuO_2) IRRADIATIONS IN THE GENERAL ELECTRIC TEST REACTOR. Burley, T. B.; Hanson, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 70p. Dep. CFSTI.

A fuel irradiation test program and capsule design are described for the evaluation of the steady state and transient performance characteristics of prototypic FTR length fuel pins. The fuel pins to be tested comprise 31 in. of mixed oxide (75% UO_2-25% PuO_2) fuel pellets clad in 0.250 in. diameter Type 304 stainless steel. The fuel pellets are 93% of theoretical density (TD) and with a 0.006 in. diametrical gap the fuel has an 88% TD smeared density. The capsule is a NaK bonded instrumented assembly designed to produce a fuel pin cladding surface temperature of 800°F and fuel central temperature of 4000°F when the fuel pin is producing 14.5 kW/ft (axial peak). The safey analysis, heat transfer calculations and operating instructions are also described. (9 references) (auth)

46081 (BNWL-1394) FAST FLUX TEST FACILITY PERIODIC TECHNICAL REPORT, MARCH-JUNE 1970. Cabell, C. P. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-2170. 183p. Dep. CFSTI.

BORON CARBIDES—radiation effects on fragmentation of B_4C pellets, (E)
—helium gas release from B_4C, effects of irradiation temperature on, (E)
FAST FLUX TEST FACILITY—design and development during March to June 1970
FAST TEST REACTOR—design and development during March to June 1970
—cooling system for, effects of stored heat in piping on thermal transients in, (T)
—fuel element failure monitoring in, xenon and krypton gas tagging for
—fuel element cladding and spacer wire stresses in, thermal and radiation effects on, (T)
—control rod worth requirements for, (T)
—structural materials for, irradiation testing of
—fuel element cladding for, radiation effects on, (E)
—structural materials for, neutron fluence limits for Type 304 stainless steel
—fuels for, fabrication specifications for
—fuels for, irradiation testing of
—fuel element cladding for, fabrication specifications for
—fuel elements for, end-closure weld specifications for
—fuel subassemblies for, fabrication of Mark II test
—physics parameters of, (E/T)
—control ring for, reactivity worth of, (E/T)
—reactivity of, effects of incoherent sodium voiding on, (T)
—shutdown of, fission product decay heat at, (E/T)
—shielding design for, evaluation of conceptual, (E/T)
—safety analyses of, (T)
NEUTRONS, FAST—effects on fast reactor control and structural materials, (E)
STAINLESS STEEL—radiation effects on mechanical and tensile properties of Type 304 and Type 316, fast neutron, (E)
—mechanical properties of Type 304, effects of high strain rates on, (E)
—fatigue crack growth in Type 304, effects of low-cycle stresses on, (E)
—tensile properties of Type 304 weldment materials, (E)
TANTALUM—radiation effects on density and elongation of, fast neutron, (E) (H.D.R.)

46082 (CEA-N-1274) INSPECTION DEVICE FOR RW 330 COMPUTER NEAR CABRI REACTOR. Da Costa Vieira, David; Merite, Bernard; Parocco, Robert (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Mar 1970. 10p. (In French). Dep. CFSTI (U. S. Sales Only).

The device is intended for inspection of the reactor control program. Inspection is achieved by the control of program duration; time base is given by the interval between two mark pulses from the computer memory drum. The program duration to be controlled is recorded in the memory-drum revolution number. During a correct program cycle a reset pulse must appear before the end of the program. The inspection device detects non-occurrence of this condition, then switches on a sounding alarm and a relay for external use. (auth)

46083 (CEA-R-3991) EXPERIMENTS IN THE REACTOR OSIRIS. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1970. 201p. (In French). Dep. CFSTI (U. S. Sales Only).

Since it was started up at the end of 1966, the swimming-pool research reactor OSIRIS has been used for numerous and varied irradiation experiments, which have necessitated the development of a certain number of specially adapted experimental devices. A brief summary is given of the main characteristics of the reactor from the point of view of its use for experiments; the general experience acquired over three years is then described, and an explanation given of the organization of the work involved for an experiment from the initial project up to the placing of the device in the reactor. A detailed description is given of the main irradiation devices available: simple capsules, such as those used for producing transuranic elements, temperature-controlled capsules fitted with instruments for carrying out, for example, creep tests, or for following in-pile changes in certain characteristics of a sample, and complex loops with independent fluid circulation (mainly gaseous) reproducing the ambient conditions of power reactors. (auth) (France)

46084 (EURFNR-778) PROGRESS REPORT ON THE SECOND QUARTER OF 1968. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 28p. (In French). Dep. CFSTI (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

The operation of the Rapsodie, Masurca, Harmonie, and other installations and studies on reactor physics and safety during the second quarter of 1968 are reported. In the Rapsodie, the power coefficient was remeasured, the argon atmosphere of one exchanger was isolated, and the Ar pipes of the primary circuit were washed with Na. In the Masurca reactor the relation between the reactivity coefficient and the temperature was established, flux charts were prepared by measurement of the reaction rate, the automatic pilot was calibrated, and the reactivity coefficients were measured by oscillation. In the Harmonie reactor spectrum measurement was made on the exponential assembly HUG II, and the results were compared with the spectrum of Masurca. In the Ermine installation measurements were made on the U2 lattice, with identical composition to that of Masurca 1B and HUG 2. (J.S.R.)

46085 (EURFNR-779) PROGRESS REPORT ON THE THIRD QUARTER OF 1968. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 15p. (In French). Dep. CFSTI (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

The operation of the Rapsodie, Masurca, Harmonie, and other installations and studies on reactor physics and safety made during the third quarter of 1968 are reported. In the Rapsodie the variations of the Na level in an intermediate exchanger were studied, the output and temperature were measured on the north terminal exchanger, displacement measurements of the primary pipes were made, and the new control of the Na inlet temperature are described. The three shutdowns and detection of fission products in the argon experienced during this quarter were discussed. A series of measurements by vertical oscillations were made in the Masurca using special fuel pellets. (J.S.R.)

46086 (IN-1338) EVALUATION OF BEARING LOADS AND CONTACT STRESSES IN THE PRIMARY COOLANT CHECK VALVE OF THE ADVANCED TEST REACTOR. Byers, N. R. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 380p. Dep. CFSTI.

Bearing failures in the ATR primary coolant check valve occurred during final stages of testing and indicated that conditions could occur that would affect the safety and reliability of reactor operation. Bearing stresses due to a varying load, a criterion for bearing material, and a guide for future bearing design are presented. By a slight extension, this method may be used to predict bearing fatigue failure and bearing life. (auth)

46087 (IN-1391) LOFT CORE LENGTH STUDY. Haire, J. C.; Brockett, G. F. (Idaho Nuclear Corp., Idaho Falls). Aug 1970. Contract AT(10-1)-1230. 61p. Dep. CFSTI.

A scoping study was performed to determine the nuclear core length and other selected parameters that are required for the Loss-of-Fluid Test (LOFT) system to have a thermal response during a loss-of-coolant accident (LOCA) similar to that of a large pressurized water reactor (PWR). This study was used as the basis for a recommendation regarding a minimum core length that would yield a thermal response similar to that of a large PWR. The general criterion for a similar thermal response is that the fuel cladding hot-spot temperature history during the time preceding the injection of emergency core coolant into the core approximate that of a large PWR. The RELAP3 computer code was used to determine the pressure, coolant enthalpy, and mass flow rate existing at the entrance to the LOFT core during a transient. These quantities were then input into the THETA1 code that was used to determine the fuel cladding temperature history. The effects of various primary system parameters, initial operating conditions, and calculational methods on the predicted core thermal response of LOFT were also determined. (auth)

46088 (NP-18272) ANNUAL REPORT, 1968. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 52p. (In French). Dep. CFSTI (U. S. Sales Only).

The BR-2 reactor has been used for studies on fast neutron reactors, gas-cooled reactors, light-water reactors, and homogeneous reactors and in studies on fissile materials and structural materials. The preparation and performance of the experiments for these different types of studies are described. Post-irradiation studies and physics studies for the irradiations at the BR-2 are also briefly considered. The research programs on fast reactors and on thermal reactors are described. Basic research on solid state physics, low energy nuclear physics, and radiobiology are briefly summarized. The production of radioisotopes, increase in uses of γ irradiations, and the Ac program for the development of a high performance source for thermoionic conversion are discussed. Health protection and safety and relations with external organizations are also cited. (J.S.R.)

46089 (ORNL-TM-3098) THE LOW-ENERGY NEUTRON SPECTRUM OF THE ORNL TOWER SHIELDING REACTOR BEAM. Freestone, R. M. Jr.; Muckenthaler, F. J.; Henry, K. M. Jr.; Clifford, C. E. (Oak Ridge National Lab., Tenn.). 24 Aug 1970. 7p. Dep. CFSTI.

An estimate of the spectrum of neutrons having energies between 0.4 and 1.5 MeV emitted by the ORNL Tower Shielding Reactor (TSR-II) has been made. Spherical, hydrogen-filled proportional counters were used to obtain the data. The unfolded result of the measurement is presented as a histogram of flux vs energy. (auth)

46090 DESIGN, BASES, AND STATUS OF THE NRTS LOSS-OF-FLUID TEST (LOFT) FACILITY. Copien, H. L. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 13: Suppl., 33-4(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46091 FLOW DUCT/RECEPTACLE EROSION-FLOW TEST. Oakley, D. J.; Webb, A. B.; Wett, J. F. (Battelle Northwest Labs., Richland, Wash.). Trans. Amer. Nucl. Soc.; 13: Suppl., 39-40(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46092 NUCLEAR SCIENCE IN THE DEMOCRATIC REPUBLIC OF THE CONGO. Malu, F. (Centre Nucleaire TRICO, Kinshasa, Congo). pp 27-31 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The Congo possesses a TRIGA Mkl reactor, the first reactor to have gone into operation on the African continent. This reactor has many uses and has been put at the disposal of the other African countries. Various experimental research projects on the irradiation and activation of samples are in progress in the Democratic Republic of the Congo. The radioisotopes produced are mainly used in national laboratories. (auth)

46093 ROLE OF RESEARCH REACTORS IN DEVELOPING COUNTRIES. Spinrad, B. I.; Tchernilin, Y. (International Atomic Energy Agency, Vienna). pp 335-51 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The conditions under which a research reactor can be useful to developing countries, and the uses to which it can be put are analyzed. Among the conditions are: availability of funds for operation, existence of a preplanned experimental program, prior formation of a sufficiently large scientific team, and an appreciation of reactor usefulness to a broad group of professions. In a developmental situation, a reactor is most efficiently utilized when it is integrated into the work of a major technical university. This permits its use for both general and special training, and for research. A number of research fields which are pursued with reactors are listed. A capability for training is, of course, particularly useful when a country anticipates embarking on a nuclear power program. Even a small reactor also presents many of the problems of operation, maintenance and servicing which must be faced in a power plant. The IAEA program of support for research reactor activities is set forth. 17 references. (auth)

46094 RESEARCH REACTORS. REVIEW OF PRESENT TRENDS IN THEIR DEVELOPMENT AND UTILIZATION. Lindsay, J. E. O. (Ghana Atomic Energy Commission, Accra). pp 353-9 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

The progress made in recent times towards the improvement of existing research reactor types is reviewed. These improvements have been concerned in the main with the application of new reactor concepts to existing designs or to modifications to existing reactor types aimed at the attainment of higher neutron fluxes or increased power levels. Considerable effort has also been directed at various national research centers towards enlarging the experimental facilities and extending the scope and potentialities of reactors at present in operation. Trends in research reactor development in Africa are described. 28 references. (auth)

46095 ROLE OF RESEARCH REACTORS IN REACTOR DEVELOPMENT PROGRAMS FOR DEVELOPING COUNTRIES WITH SPECIAL REFERENCE TO UAR EXPERIENCE. El-Mofty, O. H. (Atomic Energy Establishment, Cairo). pp 361-72 of Peaceful Uses of Atomic Energy in Africa. Vienna; International Atomic Energy Agency (1970).

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa. See STI/PUB-233; CONF-690711.

A short survey of the activities carried out at the laboratories of the Reactors Department of the UAR Atomic Energy Establishment is presented. In the field of reactor statics and kinetics studies were made on the core parmeters of the UA-RR-1. In heat transfer studies an out-of-pile loop was constructed and reactor fuel was simulated. Reactor control studies were directed to modifying the UA-RR-1 control by introducing an automatic start-up and by modernizing some components. Computational codes covering some aspects of reactor calculations were developed. The problems of transients and boiling heat transfer are being investigated theoretically and experimentally and some control problems are being studied. 39 references. (auth)

46096 COMPARISON OF SPECTRAL INDICES MEASURED IN AND CALCULATED FOR WATER-MODERATED CYLINDER-SYMMETRICAL MACROCELLS. Albert, D. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 13: 141-4(May 1970). (In German).

Spectral indices measured for moderator and fuel region of the elementary cell of an unperturbed $U_{nat}O_2$-H_2O substitution lattice and with respect to space distributions in perturbed substitution lattices are compared with calculated ones. Calculations have been made by using THERMOS program. 8 references. (auth)

46097 MEASUREMENTS OF THERMAL NEUTRON SPECTRA IN HETEROGENEOUS LATTICES BY FOIL ACTIVATION. Dixon, G. W.; Sher, R. (Stanford Univ., Calif.). Nucl. Sci. Eng.; 41: 357-66(Sep 1970).

Thermal neutron spectra have been measured with good spatial resolution within a unit cell in several H_2O-moderated natural uranium lattices and in one graphite-moderated lattice. The H_2O-moderated lattices had water-to-uranium volume ratios of 1:1, 2:1, and 3:1, with fuel rod diameters of 2.54 cm. Dysprosium-164, ^{151}Eu, ^{176}Lu, and ^{115}In were used as detectors, and both activation ratios and unfolded spectra are compared with THERMOS code calculations. The agreement between the results and the calculations is satisfactory; however, the agreement in the water regions is generally much better than in the fuel regions of the H_2O-moderated lattices. In the graphite lattice, the agreement of results

with THERMOS calculations using a free gas kernel is poor, while calculations with a crystalline kernel show better agreement. (auth)

Rocket and Space Reactors

Refer also to abstract 44697.

46098 (AI-AEC-12964) SNAP 8, CONTROL DRUM BEARING DEVELOPMENT AND EVALUATION HISTORY. Horton, P. H. (Atomics International, Canoga Park, Calif.). 15 Aug 1970. Contract AT(04-3)-701. 90p. Dep. CFSTI.

Development and testing of the SNAP 8 control drum bearings are traced from initial material selection through final design verification testing. Design of the self-aligning journal bearings relied on technology from previous SNAP 10 bearings, with material and dimension changes for operation under increased load, temperature, and life. The final design bearings, using a carbon-graphite against alumina bearing couple, successfully completed in excess of 78,000 total hours at test, with individual tests of 12,000-hr duration. (auth)

46099 COMPARISON OF CALCULATED AND MEASURED ENERGY-DEPENDENT ACTIVATION RATES FOR NERVA-TYPE REACTOR. Salah, S.; Rankin, W. D.; Oblock, V. S. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng.; 41: 367-80 (Sep 1970).

Absolute reaction rates of thermal, resonance, and threshold detectors were calculated and measured within a graphite moderated, graphite reflected critical assembly using NERVA-type fuel elements to provide verification of analytical techniques and basic neutron cross-section data. Detectors used were: Dy, In, Au, W, Mn, Cu, ^{235}U, and ^{238}U foils and S pellets. Comparison of the calculated energy-dependent reaction rates with measured values showed them to be generally within experimental uncertainties. Near the outer edge of the reactor, however, the difference between the calculated and experimental values is greater than the experimental uncertainties. The comparison of these calculations and measurements show that the spatially dependent neutron spectra are adequately predicted with the multigroup, multiregion transport calculations utilized in the analysis. (auth)

Process Heat and Desalination Reactors

Refer also to abstracts 44347 and 46004.

46100 (BARC-480) ENERGY NEEDS AND PROSPECTS FOR NUCLEAR POWER AND DESALINATION IN INDIA. Thomas, K. T.; Rajan, N. S. Sunder (Bhabha Atomic Research Centre, Bombay (India)). 1970. 15p. Dep. CFSTI (U. S. Sales Only).

The growth of the electric power industry in India since 1947 is tabulated and discussed. Hydro and fossil fuel resources in regions of the country are estimated, and the economics of coal-fired versus nuclear power stations are examined. Estimated requirements and scheduled capacities for electric power are presented through 1974. The economic potential of dual purpose reactors for power and desalination is discussed. (H.D.R.)

46101 (ORNL-TM-2977) ABSTRACTS OF PAPERS DESALINATION INFORMATION MEETING, MAY 21-22, 1970. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 62p. (CONF-700531). Dep. CFSTI.

Abstracts of 20 papers presented at the 1970 information meeting at ORNL on desalination projects are included. The abstracts are arranged under the headings: water research program, and nuclear desalination program. (D.C.C.)

46102 HYDROGEN, KEY TO THE ENERGY MARKET. De-Beni, Gianfranco; Marchetti, Cesare. Euro-Spectra; 9: 46-50(Jun 1970).

The use of nuclear reactors to produce hydrogen is described. Comparison of other heat sources with nuclear reactors for hydrogen production is presented. (D.C.C.)

46103 NUCLEAR DESALINATION. Kamal, Ismat (Univ. of California, Berkeley). Nucleus (Karachi); 6: 168-78(Oct-Dec 1969).

The major consideration in any water desalination scheme is the cost at which desalted water is obtained. This cost can be lowered considerably by combining nuclear power generation with water desalination. The various types of reactors that can be used for the desalination of sea water and the advantages of dual-purpose over single-purpose desalination plants are discussed. A frequently used method for cost allocations in dual-purpose plants is also discussed. (auth)

Marine and Portable Power Reactors

46104 (DOCKET-50238-66) N. S. SAVANNAH. Application for Transfer of License NS-1 From First Atomic Ship Transport, Inc. to Maritime Administration. (Maritime Administration, Washington, D. C.). 4 Sep 1970. 182p. Dep. CFSTI.

46105 FIRST REFUELING OF THE N. S. SAVANNAH. Hathaway, C. W. (Todd Shipyards Co., Galveston, Tex.); Mehann, R. O.; Parker, C. W. Trans. Amer. Nucl. Soc.; 13: Suppl., 33(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46106 PROGRESS TOWARDS A BRITISH-BUILT NUCLEAR-POWERED MERCHANT SHIP. Motor Ship; 50: 534-8(Feb 1970).

A brief description is given of the non-naval nuclear vessels launched to date. Work being carried out in the U. K. to develop an economic nuclear merchant ship is summarized and an attempt is made to show why the U. K. has not yet built such a vessel. Major events in the development of nuclear-powered surface ships, other than war-ships, are tabulated. It is seen that, while other maritime countries have, and are building, nuclear ships, the U. K. has for 13 years carried out feasibility studies and forming committees to investigate the economics of the application of nuclear power to merchant ships. (auth) (UK)

Production Reactors

46107 APPLICATION OF PROOF TESTING TO ASSESS K-REACTOR PIPING INTEGRITY. Carlson, P. A.; Russell, A. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 13: Suppl., 10(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46108 ACCUMULATION OF RADIONUCLIDES IN BED SEDIMENTS OF THE COLUMBIA RIVER BETWEEN THE HANFORD REACTORS AND McNARY DAM. Nelson, Jack L. (Battelle Memorial Inst., Richland, Wash.); Haushild, W. L. Water Resour. Res.; 6: 130-7(Feb 1970).

Amounts of radionuclides from the Hanford reactors contained in bed sediments of the Columbia River were estimated by two methods: from data on radionuclide concentration for the bed sediments between the reactors and McNary Dam, and from data on radionuclide discharge for river stations at Pasco, Washington, and Umatilla, Oregon. Umatilla is 3.2 kilometers below McNary Dam. Accumulations of radionuclides in the Pasco to Umatilla reach estimated by the two methods agree within about 8%. In October 1965 approximately 16,000 curies of gamma-emitting radionuclides were resident in bed sediments of the river between the Hanford reactors and McNary Dam. Concentrations and accumulations of chromium-51, zinc-65, cobalt-60, manganese-54, and scandium-46 generally are much higher near McNary Dam than they are in the vicinity of the reactors. These changes are caused by an increase downstream from the reactors in the proportion of the bed sediment that is fine grained and the proportions of the transported zinc, cobalt, manganese, and scandium radionuclides associated with sediment particles. 12 references. (auth)

Reactor Theory

46109 (BARC-481) THEORETICAL REACTOR PHYSICS STUDIES. Annual Progress Report, 1969. Rastogi, B. P. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 25p. Dep. CFSTI (U. S. Sales Only).

The work done in the Theoretical Physics Section of Reactor Engineering Division during the year 1969 is briefly discussed. Work done in the fields of heavy water reactors, water reactors, fast reactors, molten salt breeders, reactor evaluation, and reactor theory is discussed. (41 references) (auth)

Kinetics

Refer also to abstracts 46013, 46018-46020, and 46096.

46110 (RD/B/N-1674) SOME MONTE CARLO CALCULATIONS OF THE THERMAL NEUTRON DIFFUSION AREA IN A FUELLED CELL. Johnson, P. W. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1970. 10p. Dep. CFSTI (U. S. Sales Only).

A Monte Carlo program was written to test Blackburn's proposed correction to the neutron diffusion coefficient. For the cell studied, a correction of $-(17.4 \pm 2.1)\%$ was observed, in excellent agreement with the Blackburn prediction. 9 references. (auth) (UK)

46111 THREE-DIMENSIONAL METHOD FOR DESIGN STUDIES OF XENON-INDUCED SPATIAL POWER OSCILLATIONS. Kern, R. C.; Coppersmith, W. C.; Rosztoczy, Z. R. (Combustion Engineering, Inc., Windsor, Conn.). Nucl. Appl. Technol.; 9: 70-82(Jul 1970).

A three-dimensional calculational method was developed for use in studying xenon oscillations and their control. This method is based on nodal analysis and a modified one group theory and includes all major feedback mechanisms which are important in xenon transients. Comparisons were made between the results obtained with this method and with more sophisticated methods and good agreement was found in all cases. Significant reductions in computing times are obtainable with this method. (auth)

46112 METHOD OF SUBGROUPS FOR ACCOUNTING OF RESONANCE STRUCTURE OF CROSS-SECTIONS IN NEUTRON CALCULATIONS. I. Nikolaev, M. N.; Ignatov, A. A.; Isaev, N. V.; Khokhlov, V. F. At. Energ. (USSR); 29: 11-16(Jul 1970). (In Russian).

It is shown that in solving the transfer equation it is expedient to regard the neutron flux as a function of the total cross section. There has been formulated a system of effective equations and cross sections of neutron interactions, that allow the calculation of the value of an average resonance neutron flux. The method is realized in computer in the diffusion approximation. 7 references. (auth)

46113 NEUTRON STREAMING AND ANISOTROPIC EFFECTS IN DIFFUSING MEDIA WITH EMPTY CHANNELS. PART I. Ahmad, Mohammad (Pakistan Atomic Energy Commission, Karachi). Nucleus (Karachi); 6: 200-5(Oct-Dec 1969).

The results of various attempts to provide a theory of the phenomenon commonly known as neutron streaming are reviewed. While a cross-section of the more important theoretical formulae is outlined, the last section of the survey also shows how streaming is included in the steady-state diffusion theory reactor calculations as a corrective measure to the migration areas and the criticality condition. 23 references. (auth)

46114 STATISTICAL EVALUATION OF THE MAXIMUM TEMPERATURES IN REACTOR CORES. Amendola, A. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng.; 41: 343-50(Sep 1970).

A new statistical method for evaluation of hot channel and hot spot factors is presented. A new definition of "hot spot" is proposed with which the probability of exceeding critical temperatures can be correlated to the size of the zone in which they occur. In contrast to previous methods, the hot channel factors are demonstrated to be independent of the assumed spot size, provided that the uncertainties are correctly specified. Therefore, a new criterion is proposed for specification of the uncertainties which are random variables along the fuel pin axis, and the concept of a "specific standard deviation" is introduced. The different effects of the uncertainties, whether they act on single elements of the core, on groups of elements or on the whole core, are taken into account by an appropriate procedure. The statistical analysis takes into account the whole core with its particular axial and radial nominal temperature profiles. The principal results obtained by the SHØSPA code for the sodium-cooled fast reactor Na-2 are discussed. (auth)

46115 CONTINUOUS SLOWING DOWN THEORY FOR ANISOTROPIC ELASTIC NEUTRON MODERATION IN THE P_N AND B_N REPRESENTATIONS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 41: 457-61(Sep 1970).

A continuous slowing down approximation has been successfully applied to the isotropic elastic moderation of neutrons in a fast-reactor assembly. New moderating parameters were introduced to accommodate strong scattering resonances. The theory for applying this new continuous slowing down approximation to anisotropic elastic neutron moderation in the general P_N or B_N representation is presented. In the derivation, the angular dependence of the neutron flux is assumed to depend only upon the polar angle. An extended transport approximation is also presented to which higher order transport and anisotropic scattering effects are incorporated into the P_0-isotropic scattering formalism in an approximate manner. (auth)

46116 HIGHER ORDER VARIATIONAL PRINCIPLES AND ITERATIVE PROCESSES. Devooght, J. (Univ. Libre, Brussels). Nucl. Sci. Eng.; 41: 399-403(Sep 1970).

N-step iterative processes give rise to N-order variational principles. The p-hyperpower iterative process of Altman and Petryshyn is shown to be equivalent to the p-order variational principle of Kostin and Brooks. A higher order Chebychev variational principle is derived, which is independent of the normalization of the trial operator. (auth)

46117 EXACT SOLUTION OF THE NEUTRON SLOWING DOWN EQUATION. Stefanovic, D. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Sci. Eng.; 41: 394-8(Sep 1970).

The slowing down equation for an infinite homogeneous monoatomic medium is solved exactly. The cross sections depend on neutron energy. The solution is given in analytical form within each of the lethargy intervals. This analytical form is the sum of probabilities which are given by the Green functions. The calculated collision density is compared with the one obtained by Bednarz and also with an approximate Wigner formula for the case of a resonance not wider than one collision interval. For the special case of hydrogen, the present solution reduces to Bethe's solution. (auth)

46118 TIME-DEPENDENT NEUTRON TRANSPORT THEORY FOR FAST PULSED ASSEMBLIES. Knickle, H. N.; Daitch, P. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng.; 41: 404-16(Sep 1970).

The time-dependent transport equation in plane geometry is solved numerically using the double spherical harmonics angular approximation and first-order finite differences. The monoenergetic case is shown to meet both necessary and sufficient conditions for stability for reasonable values of the time step. The convergence and wave front propagation characteristics of the difference scheme are checked in special cases and found to be satisfactory. A computer program was written to solve the difference equations of the multienergy, multiregion problem. Monoenergetic and multigroup calculations are made which compare qualitatively with experimental results. (auth)

46119 INFORMATION IN NEUTRON FLUCTUATIONS. Albrecht, Robert W. (Univ. of Washington, Seattle); Seifritz, Walter. Nucl. Sci. Eng.; 41: 417-30(Sep 1970).

Fundamental concepts of information theory are introduced to show the applicability of these concepts to the analysis of statistical fluctuations in the neutron density in nuclear reactors. The application of these concepts is illustrated by considering five questions in the field of reactor noise. It is shown that information theory possesses a considerable potential for putting many questions in this field into a more rational theoretical framework and thereby unifying the field. It is also shown that a quantity defined as information can be measured and interpreted. (auth)

46120 ALTERNATING DIRECTION METHODS FOR THE REACTOR KINETICS EQUATIONS. Reed, Wm. H.; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3903. Nucl. Sci. Eng.; 41: 431-42(Sep 1970).

A class of finite difference methods known as alternating semi-implicit techniques is presented for the solution of the multigroup diffusion theory reactor kinetics equations in two space dimensions. A subset of the above class is shown to be consistent with the differential equations and numerically stable. An exponential transformation of the semidiscrete equations is shown to reduce the truncation error of the above methods so that they become practical methods for two-dimensional problems. A variety of numerical experiments are presented which illustrate the truncation error, convergence rate, and stability of a particular member of the above class. (auth)

Dynamics

Refer also to abstract 46075.

46121 INTEGRODIFFERENTIAL SYSTEM WHICH OCCURS IN REACTOR DYNAMICS. Bronikowski, Thomas A. (Marquette Univ., Milwaukee). Contract DA-31-124-ARO-D-266. Arch. Ration. Mech. Anal.; 37: 363-80(1970).

Experimental Applications

46122 (BNWL-1381-2) REACTOR PHYSICS QUARTERLY REPORT, APRIL-JUNE 1970. (Battelle-Northwest, Richland,

Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 98p. Dep. CFSTI.

CRITICAL ASSEMBLIES—critical masses of plutonium fueled water moderated lattices in CAF, (E)
HIGH-TEMPERATURE LATTICE TEST REACTOR—multiplication factor for thorium oxide (ThO_2)–uranium carbide (UC_2)–carbon HTGR lattices in, (E/T)
—reactivity temperature coefficient to 1000°C in, (E/T)
—safety rods for, temperature distribution in plates of vertical, (T)
PHYSICAL CONSTANTS TESTING REACTOR—multiplication factor for water moderated uranium oxide (UO_2)–plutonium oxide (PuO_2) lattices in, (E/T)
—multiplication factor for uranium–aluminium fueled fast core in, (E/T)
PLUTONIUM RECYCLE TEST REACTOR—fuel burnup in Batch Core of, radiochemical and mass spectrometric analysis of
REACTOR FUEL ELEMENTS—burnup of stainless steel clad mixed oxide, effects of power distribution and isotopic concentrations on, (E/T)
REACTORS, FAST—physics analysis during April to June 1970
REACTORS, THERMAL—physics analysis during April to June 1970
REACTORS, WATER-MODERATED—power distributions in uranium oxide (UO_2) and uranium oxide (UO_2)–plutonium oxide (PuO_2) fueled lattices, (E/T)
—multiplication factors in uranium oxide (UO_2) and uranium oxide (UO_2)–plutonium oxide (PuO_2) fueled lattices, (E/T)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 44166–44168, 44170, 44171, 44234, 44343, 44688, 44692, 44712, 44719, 44751, 44773, 44792, 44822, 44823, and 45993.

46123 (BNWL-1488) BURNUP DATA FROM UO_2–0.48 WT PERCENT PuO_2 FUEL. Matsen, R. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 75p. Dep. CFSTI.

Burnup data obtained from the destructive analysis of UO_2–0.48 wt % PuO_2 fuel irradiated in the Plutonium Recycle Test Reactor are presented. The measured data are partially analyzed, however no effort has been made to detect questionable data. (auth)

46124 (GEAP-10160) ZIRCALOY-CLAD UO_2 FUEL ROD EVALUATION PROGRAM. Quarterly Progress Report No. 9, November 1969–January 1970. Megerth, F. H. (comp.) (General Electric Co., San Jose, Calif. Reactor Fuels and Reprocessing Dept.). Feb 1970. Contract AT(04-3)-189. 22p. Dep. CFSTI.

AMERICIUM ISOTOPES Am-242—content in high burnup uranium oxide (UO_2) fuels, (E)
CURIUM ISOTOPES Cm-243—content in high burnup uranium oxide (UO_2) fuels, (E)
CURIUM ISOTOPES Cm-245—content in high burnup uranium oxide (UO_2) fuels, (E)
CURIUM ISOTOPES Cm-246—content in high burnup uranium oxide (UO_2) fuels, (E)
NEPTUNIUM ISOTOPES Np-237—content in high burnup uranium oxide (UO_2) fuels, (E)
REACTOR FUEL ELEMENTS—performance of Zircaloy clad uranium oxide (UO_2), high burnup, (E)
REACTOR FUELS—isotopic composition of high burnup uranium oxide (UO_2), complete, (E)
—burnup of uranium oxide (UO_2), evaluation program for high, (E)
ZIRCALOY-2—tensile properties of irradiated rings of, transverse, (E) (H.D.R.)

46125 DEVELOPMENT AND APPLICATION OF REMOTE HANDLING TECHNIQUES. Feldman, M. J. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 13: Suppl., 35(1970).

From Conference on Power Reactor Systems and Components, Williamsburg, Virginia. See CONF-700904.

46126 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR INVESTIGATING THE NEUTRON PHYSICAL PROPERTIES OF TEST BODIES. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,194,913. 17 Jun 1970. Priority date 18 Jun 1966, Germany.

An apparatus for examining and measuring neutron physical properties of test bodies, particularly for checking operational elements in reactors comprises a test reactor, means for measuring the power level of the reactor, a shielding element providing neutron separation between the test reactor and the body to be tested, and drive means for producing relative movement between the test body and the shielding element so that relative movement permits different regions of the test body to be examined. The shielding element has a window whose dimensions correspond to the size of the regions of the test body to be examined, and each region is examined as it is moved into register with the window. (B.L.M.)

46127 SYMPOSIUM ON THEORETICAL MODELS FOR PREDICTING IN-REACTOR PERFORMANCE OF FUEL AND CLADDING MATERIALS, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30–DECEMBER 4, 1969. Nucl. Appl. Technol.; 9: 1-69 (Jul 1970). (CONF-691126).

Twenty papers on fuel and cladding performance models were presented. The papers were organized according to the following topical interests: (1) cladding performance models (6 papers); (2) fuel performance models (7 papers); and (3) integrated fuel-element-performance models (7 papers). The papers were published in the above order in three consecutive issues of Nuclear Applications and Technology beginning with Volume 9, Number 1. A separate abstract was prepared for each paper. Abstracts for the 7 papers on integrated fuel-element-performance models were previously included as 24: 38550, 24: 38551, 24: 38552, 24: 38553, 24: 38646, 24: 39673, and 24: 41017. (H.D.R.)

For abstracts of individual papers see: 44712, 44743–44745, 46049, and 46128.

46128 THEORETICAL ANALYSIS OF CLADDING STRESSES AND STRAINS PRODUCED BY EXPANSION OF CRACKED FUEL PELLETS. Gittus, J. H.; Howl, D. A.; Hughes, H. (United Kingdom Atomic Energy Authority, Preston, Eng.). Nucl. Appl. Technol.; 9: 40-6(Jul 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

The stress and strain distributions produced in nuclear fuel element cladding by the expansion of cracked pellets are calculated both analytically and by numerical methods. As the radial (and transverse) pellet cracks open, the tendency for the cladding to stretch preferentially over them is reduced by frictional sliding at the pellet-clad interface. The frictional forces opposing sliding are intensified by a high coolant pressure (which holds the can onto the fuel) while the ability of the clad to resist the frictional forces without being locally deformed depends on its strength. The coefficient of friction, the angle between adjacent radial pellet cracks and the creep properties of the clad have, in theory, strong effects upon the tendency for clad-strain to be concentrated over opening pellet cracks: confirmation of the correctness of these deductions has been obtained from laboratory experiments in which cladding has been stretched by cracked pellets on an expanding mandrel. The numerical analysis enabled a detailed study of the strain-concentrating processes to be made, revealing that swelling of the pellet during a period at reduced heat rating increases its diameter so that, when high rating operation is resumed and the pellet expands, the cladding is stretched by an amount that depends on the magnitude of the prior swelling. During the expansion of the fuel-pellet, the radial cracks in it open up and preferentially strain the adjacent cladding so that the clad-strain due to fuel-swelling, like that due to thermal expansion of the fuel, tends to be concentrated in arcs of cladding adjacent to pellet-cracks. This process is repetitive, occurs whatever the magnitude of the coolant pressure and is accentuated by the presence of a circumferential temperature gradient in the cladding. (auth)

46129 SYMPOSIUM ON THEORETICAL MODELS FOR PREDICTING IN-REACTOR PERFORMANCE OF FUEL AND CLADDING MATERIALS, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30–DECEMBER 4, 1969. Nucl. Appl. Technol.; 9: 121-217 (Aug 1970). (CONF-691126).

Twenty papers on fuel and cladding performance models were presented. The papers were organized according to the following topical interests: (1) cladding performance models (6 papers); (2) fuel performance models (7 papers); and (3) integrated fuel-element-performance models (7 papers). The papers were published in the above order in three consecutive issues of Nuclear Applications and Technology beginning with Volume 9, Number 1. A separate abstract was prepared for each paper. Abstracts for the 7 papers on integrated fuel-element-performance models were previously included as 24: 38550, 24: 38551, 24: 38552, 24: 38553, 24: 38646, 24: 39673, and 24: 41017. (H.D.R.)

For abstracts of individual papers see: 44823, 45050, and 46130–46134.

46130 THEORIES OF SWELLING AND GAS RETENTION IN CERAMIC FUELS. Frost, Brian R. T. (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 9: 128-40(Aug 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

The development of models of fuel-element performance requires among other things a detailed, quantitative understanding of fuel swelling and fission gas release. The current state of knowledge on these phenomena is reviewed. It is shown that gas bubbles play an important role in both swelling and gas release, that a knowledge of fuel operating history is essential to quantitative predictions, and that the migration of cesium will greatly influence local swelling rates. Finally, an indication is given of the areas toward which future studies should be directed. (auth)

46131 FISSION GAS SWELLING MODEL INCORPORATING RE-SOLUTION EFFECTS. Dollins, C. C.; Ocken, H. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Appl. Technol.; 9: 141-7(Aug 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

Current fuel swelling models based upon the growth of fission gas bubbles do not consider effects due to radiation induced re-solution phenomena. A fission gas swelling model which assumes that fission fragments will destroy existing gas bubbles and maintain the resulting gas atoms in supersaturated solid solution is described. Such a model should be particularly applicable to fuels operating at low temperatures and high fission rates. Bubble nucleation and growth then take place until another fission fragment again passes through the same region. Bubble growth is calculated using reaction rate theory over the period of time in which no radiation damage occurs. The model predicts bubble growth significantly smaller than that experimentally determined in UO_2. This discrepancy is attributed to assumptions made in defining the re-solution mechanism. The model implies that fission gas bubble growth is a state function independent of path. (auth)

46132 STATISTICAL FUEL SWELLING AND FISSION GAS RELEASE MODEL. Warner, H. R.; Nichols, F. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Appl. Technol.; 9: 148-66(Aug 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

A computer simulation of a fuel region was developed based on movement of fission-gas bubbles in solids under a thermal gradient. Within this region, fission gas events are followed via a Monte Carlo technique. Individual bubbles are followed through their time history from nucleation to release from the fuel, with interactions at dislocations and grain boundaries. Saturation in gaseous swelling at elevated temperature is predicted. A maximum in swelling is predicted at intermediate temperatures for a given burnup. These swelling and gas release predictions at high temperatures are in good agreement with experimental results. A low temperature modification of dislocation density is required to allow for effects dominant at low temperature which are not included in the current version of the program. With this low temperature modification, swelling predictions are in good agreement with experimental observations over the entire operating temperature range. (auth)

46133 INTERPRETATIONS OF FISSION GAS BEHAVIOR IN REFRACTORY FUELS. Ritzman, R. L.; Markworth, A. J.; Oldfield, W.; Chubb, W. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Appl. Technol.; 9: 167-87(Aug 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

The swelling of the refractory nuclear fuels, UO_2, UN, and UC, at temperatures of the order of 1700°C is related to the behavior of the fission gases as these gases make their way out of the fuels. In all three fuels, the fission gases first precipitate to form a two-phase system consisting of solid fuel and gaseous precipitates. These precipitates or bubbles grow in-reactor mainly by the accretion of new fission gas atoms. New gas atoms diffuse to the older bubbles (which are formed in the first few minutes of irradiation) causing these bubbles to grow and to swell the fuel. In UC, this process continues with very little change to produce rather large amounts of swelling. However, at about 10 volume % swelling of UC, bubbles begin to overlap to form channels and gas release begins to accelerate. In UN and UO_2 at about 1700°C, UN and UO_2 vapors begin to migrate across the growing bubbles as a result of the temperature gradients usually found in fuels in-reactor. This process which is a form of zone refining results in rapid and efficient gas collection and release. This gas release markedly reduces the stresses applied by UN and UO_2 to their claddings; but the zone refining process does not completely eliminate swelling stresses because swelling precedes gas release. Also the zone refining or "restructuring" process tends to eliminate built-in porosity; so that while built-in porosity is very effective in limiting the swelling of UC, such porosity is relatively ineffective in reducing the swelling of UN and UO_2 at temperatures where restructuring is rapid. These processes are described in terms of classical chemical and physical metallurgical models; and the validity of the models is illustrated, although not necessarily proved, by the results of high-temperature irradiation experiments. (44 references) (auth)

46134 COMETHE II: A COMPUTER CODE FOR PREDICTING THE MECHANICAL AND THERMAL BEHAVIOR OF A FUEL PIN. Godesar, R.; Guyette, M.; Hoppe, N. (Belgonucleaire, Brussels). Nucl. Appl. Technol.; 9: 205-17(Aug 1970).

From Symposium on Theoretical Models for Predicting In-Reactor Performance of Fuel and Cladding Materials, San Francisco, Calif. See CONF-691126.

The COMETHE II computer program was formulated to predict the thermal and mechanical behavior of fuel pins during their irradiation life. It calculates, in particular, the temperature distribution, the radial and axial fuel swelling and expansion, the fission gas release, the stresses and the strains in the cladding. COMETHE II results are compared with experimental data for different burnups and thermal ratings. The agreement obtained with the experiments is rather good. The capabilities of the COMETHE II program are illustrated by a parametric study of the gap width influence on the maximum center temperature and on the strain of the sheath. (13 references) (auth)

46135 ACCURATE ABSOLUTE DETERMINATION OF FISSION DENSITIES IN FUEL RODS BY MEANS OF SOLID-STATE TRACK DETECTORS. de Coster, M.; Langela, D. (SCK–CEN, Mol, Belg.). Nucl. Appl. Technol.; 9: 229-32(Aug 1970).

It is shown that an accurate determination of the fission rate in fuel elements can be obtained by the technique of solid state track detectors. The method gives: (1) the radial variation; (2) the absolute value of the fission rate, by application of the measured value of the mean path length of the fission products in the fuel. The quality of the results is independent of the neutron spectrum during the irradiation. In a particular case (thermal flux), results deduced from measurements performed with solid state track detectors are compared with those obtained by the fissile detector (activation) technique. The agreement is excellent. (auth)

46136 DIGITAL-MODEL DESIGN FOR NUCLEAR REACTOR COMPUTATION AND CONTROL. Tzafestas, S. G. (Democritus Nuclear Research Center, Athens). Nucl. Instrum. Methods; 84: 207-10(1970).

The problem of designing a digital nuclear reactor model for off- or on-line computation and control is considered. Two techniques are studied. In the first, which is analytical, all parameters of the reactor, including reactivity, must be known. In the second, which is computational, some of them may be unknown. These parameters are computed on the basis of neutron population measurements. The application of the results to stochastic nuclear reactor systems is illustrated, and some computer results are provided which show and compare the effectiveness of the above design techniques. (auth)

GENERAL

46137 (BNWL-SA-2727) USE OF ACOUSTIC EMISSION AS A WELD QUALITY MONITOR. Jolly, W. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1969. Contract AT(45-1)-1830. 20p. (CONF-690962-1). Dep. CFSTI.
From 24th Annual Petroleum Mechanical Engineering Conference, Tulsa, Okla.

46138 (CONF-700810-25) ENVIRONMENTAL ASPECTS OF POWER PLANTS. Niemeyer, L. E.; McCormick, R. A.; Ludwig, J. H. (National Air Pollution Control Administration, Washington, D. C.). [1970]. 17p. (SM-146/42).
From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.
The goals and status of the current NAPCA research programs include the following: the dispersion and ground-level concentrations of the effluents from tall stacks, the problem arising from the escape of large quantities of water vapor from cooling towers into the environment, the transformation of sulfur compounds in power plant plumes, and the removal of pollutants by natural atmospheric cleansing processes. Criteria are outlined for the siting of future large plants to minimize their impact on environmental quality. (auth)

46139 (COO-1001-23) EFFECTS OF POLYFUNCTIONAL ANIONS ON THE ELECTRON TRANSFER BETWEEN METAL IONS IN SOLUTION. Final Report. Brubaker, Carl H. Jr. (Michigan State Univ., East Lansing. Dept. of Chemistry). [1970]. Contract AT(11-1)-1001. 3p. Dep. CFSTI.

46140 (COO-1319-81) EFFECT OF ALLOY COMPOSITION ON THE STRESS CORROSION CRACKING OF Fe-Cr-Ni BASE ALLOYS. Royuela, J. J.; Raredon, T. L.; Serrate, E.; Morin, C. R.; Farrar, R. V.; Staehle, R. W. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). 9 Jan 1970. Contract AT-(11-1)-1319. 109p. Dep. CFSTI.

46141 (COO-1422-77) BONE MINERAL CONTENT IN WAINWRIGHT ESKIMO: PRELIMINARY REPORT. Mazess, Richard B. (Wisconsin Univ., Madison. Dept. of Radiology). [1969]. 4p. (CONF-691216-1). Dep. CFSTI.
From American Association for Advancement of Science Meeting, Boston, Mass.

46142 (COO-1488-20) INVESTIGATIONS OF NUCLEAR AND ELECTRONIC SPIN WAVES BY PARALLEL PUMPING. Hinderks, Larry W. (Kansas Univ., Lawrence). Jul 1970. Contract AT-(11-1)-1488. 103p. Dep. CFSTI.
Thesis.

46143 (COO-1616-14) STUDIES OF NICKELOUS AND COBALTOUS OXIDE AND EFFECTS OF n-TYPE AND p-TYPE DOPANTS. Helms, William Rives (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. Contract AT(11-1)-1616. 95p. Dep. CFSTI.
Thesis.

46144 (COO-1626-2) FINAL REPORT [ON MUSCLE, BONE, AND MODEL SYSTEMS]. Bratton, Clyde B. (Case Western Reserve Univ., Cleveland, Ohio). [nd]. Contract AT(11-1)-1626. 3p. Dep. CFSTI.

46145 (CTC-37) CONSOLE-ORIENTED INFORMATION STORAGE AND RETRIEVAL SYSTEM FOR THE NUCLEAR SAFETY INFORMATION CENTER. Stoutt, B. H.; Yount, S. L. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 4 Sep 1970. Contract W-7405-eng-26. 121p. Dep. CFSTI.

46146 (CTC-38) AN ANALYSIS OF (r,ϕ,θ) INSPECTION MACHINE. Brooks, A. A.; Hammerling, F. D. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 4 Sep 1970. Contract W-7405-eng-26. 53p. Dep. CFSTI.

46147 (NYO-3468-16) STUDIES ON THE LOCALIZATION OF RADIOLABELED ANTIBODIES TO A MOUSE MYELOMA PROTEIN. Reif, Arnold E. (Tufts Univ., Boston, Mass. Dept. of Surgery. Boston City Hospital, Mass.). 25 May 1970. 16p. (CONF-700507-2). Dep. CFSTI.
From 10th International Cancer Congress, Houston, Tex.

46148 (ORNL-3300(Vol.9)) PUBLICATIONS, REPORTS, AND PAPERS FOR 1969 FROM OAK RIDGE NATIONAL LABORATORY. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 136p. Dep. CFSTI.

46149 (ORNL-TM-2614) LOW-ENERGY ELECTRON ATTACHMENT TO POLYATOMIC MOLECULES AND NEGATIVE ION LIFETIMES. Collins, P. M.; Christophorou, L. G.; Carter, J. G. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 153p. Dep. CFSTI.
Thesis. Submitted by P. M. Collins to Univ. of Tennessee, Knoxville.

46150 (ORNL-TM-3079) FORTRAN-360 SUBROUTINE PACKAGE FOR PRODUCING PRINTED LINEAR, SEMILOGARITHMIC OR LOGARITHMIC GRAPHS. Thompson, C. L. (Oak Ridge National Lab., Tenn.). 6 Aug 1970. 22p. Dep. CFSTI.

46151 (ORNL-TM-3115) PHASE-PLANE ANALYSIS OF NONLINEAR, SECOND-ORDER, ORDINARY DIFFERENTIAL EQUATIONS. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). 24 Aug 1970. Contract W-7405-eng-26. 39p. Dep. CFSTI.

46152 (ORO-1643-104) DEVELOPMENT OF RELATIVELY STAGNANT IODINE POOLS IN THYROIDS OF RATS. Van Middlesworth, L. (Tennessee Univ., Memphis. Dept. of Physiology and Biophysics). [1970]. 9p. (CONF-700621-1). Dep. CFSTI.
From 6th International Thyroid Conference, Vienna, Austria.

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46154 (SC-DR-70-306) DEVELOPMENT OF XENON LAMP EXPLOSIVES INITIATOR. Higgins, P. B.; Kinsey, C. H. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 32p. Dep. CFSTI.

46155 (SC-RR-70-439) DRY-HEAT STERILIZATION MODELING: INTERIM REPORT. Brannen, J. P. (Sandia Labs., Albuquerque, N. Mex.). Aug 1970. 107p. Dep. CFSTI.

46156 (TID-25498) WEAK SOLUTIONS OF A MILDLY NONLINEAR DIRICHLET PROBLEM AND A FINITE DIFFERENCE APPROXIMATION SCHEME. Rosenzweig, Michael B. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Mar 1970. Contract AT(40-1)-3343/3. 67p. (BN-647). Dep. CFSTI.

46157 (TID-25502) EFFECT OF SOYBEAN TRYPSIN INHIBITORS ON PANCREATIC SELENOMETHIONINE UPTAKE AND PANCREATIC WEIGHT IN THE RAT. Van Amburg, A.; Studer, R.; Potchen, E. J. (Washington Univ., St. Louis, Mo. Dept. of Radiology). [1970]. 4p. Dep. CFSTI.

46158 (UCRL-18953) ELECTRONIC DENSITIES OF STATES FROM X-RAY PHOTOELECTRON SPECTROSCOPY. Fadley, C. S.; Shirley, D. A. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan 1970. Contract W-7405-eng-48. 58p. (CONF-691127-1). Dep. CFSTI.
From Symposium of Electronic Density of States, Gaithersburg, Md.

46159 (UCRL-19899) ESTIMATION OF PROTEIN QUANTITY AND QUALITY BY X-RAY PHOTOELECTRON SPECTROSCOPY. Klein, Melvin P.; Kramer, Leo N. (California Univ., Berkeley. Lawrence Radiation Lab.). 10 Jun 1970. Contract W-7405-eng-48. 14p. (CONF-700612-2). Dep. CFSTI.
From Symposium on Plant Protein Resources, Vienna, Austria.

46160 (UCRL-20034) CAMAC: A STANDARD FOR DIGITAL DATA HANDLING. Mack, Dick A. (California Univ., Berkeley. Lawrence Radiation Lab.). Jul 1970. Contract W-7405-eng-48. 13p. (CONF-700620-1). Dep. CFSTI.
From American Physical Society, Canadian Association of Physicists, and Sociedad Mexicana de Fisica Meeting, Winnipeg, Canada.

46161 (UCRL-72485) CALIBRATION OF IMPEDANCE METERS AND BRIDGES TO 50 MHz. Bostwick, W. E. (California Univ., Livermore. Lawrence Radiation Lab.). 23 Jun 1970. 6p. (CONF-701005-1). Dep. CFSTI.
From 25th Annual Conference on Instrument Society of America, Philadelphia, Pa.

46162 (UCRL-72634) FINITE DIFFERENCE SCHEME FOR CALCULATING PROBLEMS IN THREE SPACE DIMENSIONS AND TIME. Wilkins, M. L.; French, S. J.; Sorem, M. (Cali-

fornia Univ., Livermore. Lawrence Radiation Lab.). 13 Aug 1970. 5p. (CONF-700906-1). Dep. CFSTI.
From 2nd International Conference on Numerical Methods in Fluid Dynamics, Berkeley, Calif.

46163 (UR-49-1335) METABOLISM AND BILIARY EXCRETION OF PHENANTHRIDINIUM SALTS AND OTHER QUATERNARY AMMONIUM COMPOUNDS. Mac Gregor, James T. (Rochester Univ., N. Y.). 1970. 100p. Dep. CFSTI.
Thesis.

46164 (Y-1737) AN AUTOMATIC LEVEL COMPENSATION SYSTEM FOR LASER INTERFEROMETERS. Baldauf, W. A. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 21 Aug 1970. Contract W-7405-eng-26. 32p. Dep. CFSTI.

46165 (Y-DA-3514) ELIMINATION OF PHASE DISTORTION IN FILTERS USING DIGITAL TECHNIQUES. Feezell, R. R.; Marcum, R. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). [1969]. Contract W-7405-eng-26. 19p. Dep. CFSTI.

46166 NUCLEAR ENGINEERING INTERNSHIPS. Carter, Robert L. (Univ. of Missouri, Columbia). Nucl. Appl. Technol.; 9: 274-7(Aug 1970).

Regional enclaves of industry and associations of neighboring universities have devised formalized programs for providing internship experiences for graduate students and residencies for post-doctoral fellows. As an example of the former, seven years' activity of the Summer Engineering Practice School at Argonne National Laboratory is reviewed. Subsequent performance of former students has shown clear evidence of maturation resulting from early contact with working scientists. By-products have been significant industrial contributions by the students, and useful exchanges between industrial and academic scientists associated with the students. (auth)